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Ouray Silver Mines

DRAFT ENGINEERING EVALUATION and COST ANALYSIS (EE/CA)

Atlas Mill Site Tailings

Prepared for

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
BABE	Biological Assessment/Biological Evaluation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic feet per second
CSM	Conceptual Site Model
DRMS	Division of Reclamation, Mining and Safety, a part of the Colorado Department of Natural Resources
EE/CA	Engineering Evaluation / Cost Analysis
EPA	Environmental Protection Agency or US EPA
GMUG	Grand Mesa, Uncompahgre and Gunnison National Forest
mg/kg	milligrams per kilogram, on a dry weight basis, equivalent to parts per million (ppm)
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
OSMI	Ouray Silver Mines Incorporated
RAG	Removal Action Goal
SEP	Supplemental Environmental Project
TCA	Total Constituent Analysis. Soil or sediment samples are digested in strong acids to create an extract for analysis. The extract is analyzed to determine constituent concentrations and the results are reported in mass per unit mass (e.g. mg/kg). A total constituent analysis does not provide results equivalent to a toxicity characteristic leaching procedure (TCLP); however, it is possible to estimate TCLP concentrations from the results of a total constituent analysis
TU	Trout Unlimited
µg/l	micrograms per liter, equivalent to parts per billion (ppb)
USFS	United States Forest Service
UWP	Uncompahgre Watershed Partnership
WOUS	Waters of the United States
WQCD	Water Quality Control Division, a division of the Colorado Department of Public Health and Environment
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) was prepared to identify alternatives for a non-time critical removal action of tailings at the Atlas Mill site ("Site") located in the Canyon Creek drainage in the Grand Mesa, Uncompahgre and Gunnison National Forests (GMUG). This removal action is being implemented on a voluntary basis in partnership with Trout Unlimited (TU), United States Forest Service (USFS), Environmental Protection Agency (EPA), Uncompahgre Watershed Partnership (UWP) and Ouray Silver Mines Incorporated (OSMI) and is being funded through use of a supplemental environmental project (SEP) resulting from a penalty to settle past Water Quality Control Act violations. The EE/CA was developed in accordance with Environmental Protection Agency (EPA)/540/F-94/009 "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (EPA, 1993).

As is common with all Removal Actions (RAs), a need and subsequent action is determined based on eight factors listed in the National Contingency Plan (NCP) under 40 CFR Subpart E 300.415 (b)(2). These factors specifically focus on controlling source areas of contamination at hazardous sites abating, preventing, minimizing, stabilizing, mitigating, or eliminating the potential release of hazardous substances. The specific removal factors that pertain to this project and scope of work are IV and V which are:

- IV – High levels of hazardous substances, pollutants, or contaminants in surface soils that may migrate.
- V – Weather conditions (avalanches) may cause hazardous substance or pollutants/contaminants to migrate or be released.

By completing removal actions that focus on the above factors, partners anticipate the following added benefits while preventing contaminants from migrating off-site.

- Stabilization of contaminated material on-site while reducing ability of that material to migrate or be mobilized off-site;
- improve water quality in Sneffels Creek;
- reduce potential risks to the environment (ecological and aquatic receptors) from exposure to mill tailings and other mine wastes at the Site;
- control runoff from mine waste and minimize erosion of historic mill tailings; and
- stabilize the streambank along appropriate reaches of Sneffels Creek to prevent erosion of tailings during high flow conditions.

The Site consists of several dispersed waste rock piles and two distinct tailings deposits, which have the potential to contribute metals loading to Sneffels Creek. This EE/CA identifies and evaluates five potential removal actions for reducing migration of

contaminated material off-site by stormwater, snow melt, or avalanches coming into contact with the historical tailings and waste rock prior to entering Sneffels Creek.

The five removal action alternatives identified are:

1) no action;
2) cover exposed tailings and waste rock, waste rock surface water controls;
3) in-situ phytostabilization of tailings/waste, grading and revegetation. Surface water controls, and stream bank stabilization;
4) offsite removal and disposal; and
5) repository construction

These five alternatives were evaluated using four criteria: 1) whether the alternative achieved the removal action goal/factor, 2) effectiveness, 3) implementability, and 4) cost. Alternative 3, which focuses on in-situ phytostabilization of mine tailings/waste, surface water controls, amendments, and streambank stabilization, is the recommended alternative. Specific breakdown of associated actions/tasks, and justification for selection is discussed later in this document.

The EE/CA considers the nature of the contamination, removal factors, potential risks to ecological and human health and the environment and identifies potential removal actions for Site restoration. It also presents a recommended alternative based on a comparative analysis. Estimated costs are provided in the appendices.

The following sections are included in the EE/CA:

- Introduction
- Site Characterization
- Removal Action Goals (RAG) and Documentation of ARARs
- Identification and Analysis of Removal Action Alternatives
- Comparative Analysis of Removal Action Alternatives
- Data Gaps
- Recommended Removal Action Alternative
- References.

1.0 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) is being prepared for future restoration activities of tailings and waste rock at the Atlas Mill site (Site) located in the Canyon Creek drainage in the Grand Mesa, Uncompahgre and Gunnison National Forests (GMUG). Ouray Silver Mines Incorporated (OSMI) has proposed a supplemental environmental project (SEP) to reclaim the Atlas Mill tailings, which fall on both U.S. Forest Service (USFS) system lands and OSMI property. The mixed ownership of the site suggests that project work be in accordance with EPA/540/F-94/009 "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (EPA, 1993), thus requiring a current EE/CA. This work is being completed on a voluntary basis in partnership with Trout Unlimited (TU), USFS, EPA, the Division of Reclamation, Mining and Safety (DRMS), OSMI, and Uncompahgre Watershed Partnership (UWP). The Non-Time Critical Removal Action process has been selected for this project because a planning period of at least six months has existed before on-site activities are being proposed for at the Site. This is in accordance with the National Contingency Plan (NCP) and Section 415(b)(4) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). Specifically, the agency (USFS) has deemed that current site conditions warrant a removal action due to threat to public health or welfare of the United States or the environment. Therefore, per section 40 CFR 300.415(b)(2), the lead agency will carry out this removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of release of the contaminated substances on site. Because the USFS has set a precedent for stabilizing contaminated materials on site at abandoned mine land (AML) sites across Colorado, the goal of the removal action will focus on stabilization of said wastes. It will also be the intent of the selected removal action alternative to limit the migration of materials off-site.

This EE/CA identifies and evaluates removal action alternatives to reduce potential risk to the aquatic and terrestrial ecosystems posed by surface waters coming into contact with historical tailings and waste rock. The resulting non-point source loading of metals to Sneffels Creek has been shown to have the potential to degrade downstream water quality. The screening criteria used for evaluation of removal alternatives are:

- ability to achieve Removal Action Goals;
- effectiveness;
- implementability; and
- cost.

Section 2, Site Characterization, describes the Site background including the hydrology, hydrogeology and geologic conditions of the Site; describes the source, nature, and extent of contamination; provides a human health and ecological risk assessment; presents a conceptual site model (CSM), and discusses land ownership at the Site. Section 3 identifies removal action

goals and applicable or relevant and appropriate requirements (ARARs). Section 4 provides identification and analysis of removal action alternatives. Section 5 presents a comparative analysis of removal action alternatives. Section 6 presents data gaps which need to be filled in order to proceed from conceptual to detailed design. Section 7 provides specific steps of the recommended alternative along with a rough order of magnitude cost estimate.

1.1 Purpose and Objectives

The purpose and objective of the EE/CA is to identify a removal action alternative that stabilizes hazardous material and reduces likelihood of off-site migration. The Alternative should also exhibit the best cost-benefit ratio. Based on a recent assessment report and historical investigations, the presence of tailings and waste rock materials may pose a risk to human health and/or the environment both at the Site and within Sneffels Creek, which is immediately adjacent to the Site. The EE/CA considers the nature and extent of contamination and how potential removal actions fit into the overall strategy for the Site remediation.

The objectives of this EE/CA are to:

- assess results of previous studies and available data;
- identify overall Removal Action Goals for the removal action and develop a list ARARs for the Site;
- identify removal action alternatives that will potentially meet ARARs;
- partner with TU, USFS, EPA, DRMS and UWP to evaluate preferred alternatives for further consideration;
- develop estimated construction costs and long-term maintenance requirements and costs; and
- identify a preferred alternative and satisfy the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) administrative record requirements for documenting the selected removal action.

1.2 Prior Work at the Site

There have been several prior studies completed at the Site, which are described below in chronological order.

1.2.1 Draft EE/CA for Four Mine Areas in Canyon Creek Drainage (Dec 2001)

A draft EE/CA was prepared by Montgomery Watson in December 2001 on behalf of the Trust for Public Land. The EE/CA was requested by the USFS in its report “The Red Mountain Project Phase 1: Ouray County Hazardous Materials Report” (USFS, 2000). The 2001 EE/CA included an evaluation of non-time critical removal actions for the Site and was requested by the USFS when ownership of certain claims was transferred to the USFS. To our knowledge, the 2001

EE/CA was never finalized, however, much of the information contained in the 2001 EE/CA is still relevant and was used as the basis for developing this updated EE/CA.

1.2.2 Wetlands Delineation and Preliminary Jurisdictional Determination (August 2015)

A wetlands delineation report was completed in August 2015 by WestWater Engineering on behalf of Fortune Silver Mines, the former owner of the Revenue Virginius Mine. The study area included the Site and was initiated by the former mine owner to characterize wetlands extents for both a proposed tailings restoration and stream bank stabilization project and to facilitate wetlands protection during construction of permitted mine facilities. The results of this study were used in developing the list of remedial action alternatives and to avoid sensitive wetland areas and waters of the United States (WOTUS) during the Atlas Mill remedial activities.

1.2.3 Biological Assessment/Biological Evaluation/MIS Report, Atlas Mill Remediation Project (September 2015)

A Biological Assessment/Biological Evaluation (BABE) was completed in September 2015 by the Gault Group on behalf of the USFS for the Site for a tailings restoration and stream bank stabilization project completed in partnership with the Colorado Division of Reclamation, Mining and Safety (DRMS). The purpose of the BABE was to assess the effects of a proposed remediation project on federal listed threatened and endangered species.

The BABE report concluded that there would be no measurable effects on threatened and endangered species or management indicator species as a result of the proposed reclamation work. The work proposed by this EE/CA is consistent with the work previously proposed as part of the Atlas Mill Remediation Project and therefore, we have assumed the conclusions made by the BABE report are still relevant.

1.2.4 Assessment Report: Atlas Mill Near Ouray, Colorado (July 2018)

The Assessment Report was completed in July 2018 by Alpine Environmental Consultants, LLC on behalf of the UWP. The objective of the Assessment Report was to describe Site characteristics and prior sampling activities, summarize existing data, and assess potential contaminant pathways to demonstrate a need for reclamation to reduce environmental hazards

and improve water quality in Sneffels Creek. The information presented in this EE/CA relies upon the work performed and reported in the Assessment Report.

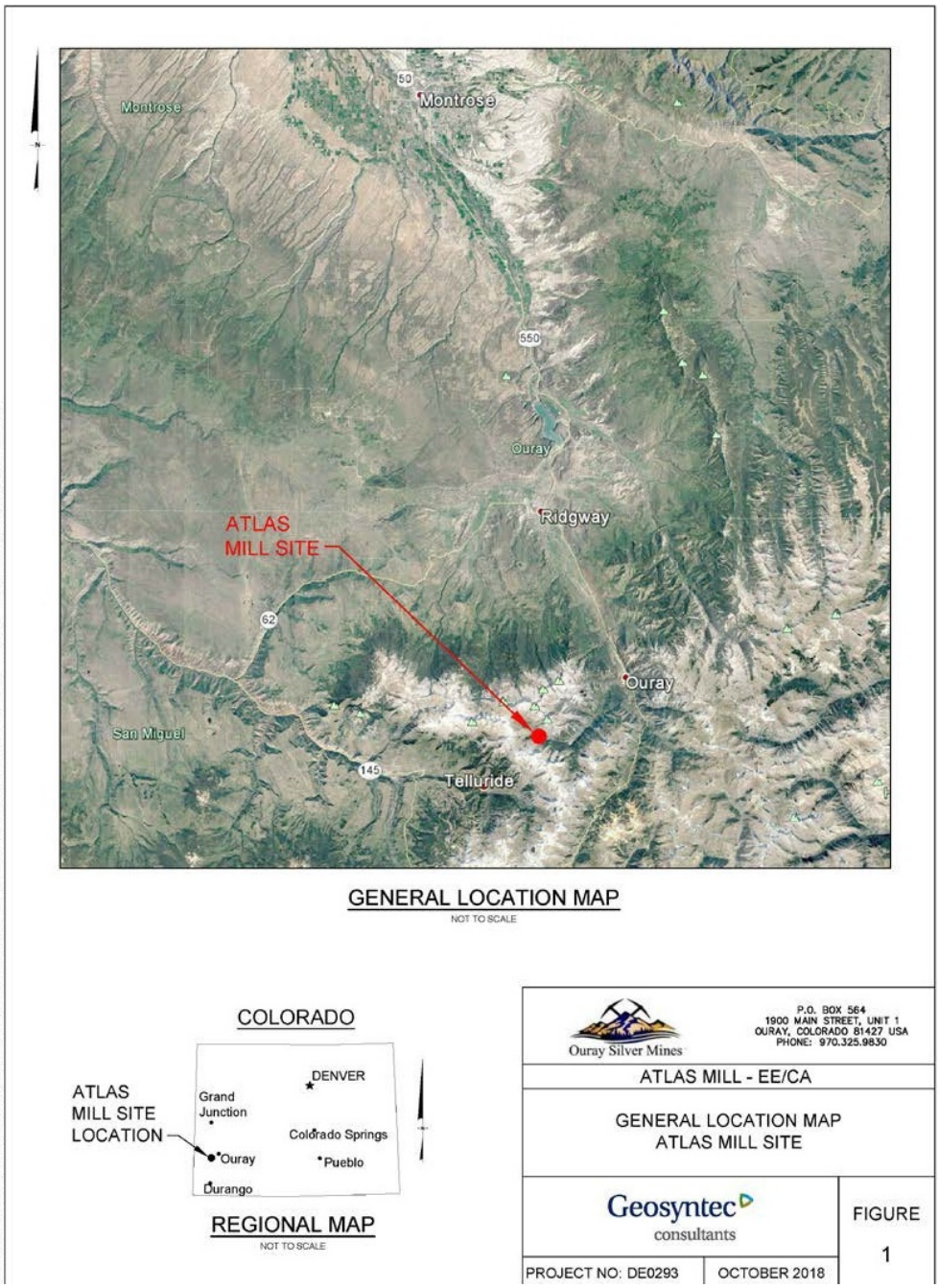


Figure 1.1: General location map showing Atlas Mine/Mill Site location with repsect to major towns and cities in Colorado.

2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

This section includes general information for the Canyon Creek area as well as a discussion of information specific to the Site. The Uncompahgre River watershed and the location of the Site included in this EE/CA are shown on Figure 1.

2.1.1 Site History

Mining operations in the Uncompahgre watershed began in 1874 near Poughkeepsie Gulch and increased in 1875 with the influx of miners moving into the region down the Uncompahgre River and Bear Creek drainages to the Ouray area. That year discoveries were made in what is presently called "Box Canyon." These discoveries included the Fisherman and Trout lodes and the Mineral Farm Mine located near the confluence of Canyon Creek and the Uncompahgre River. Additional discoveries in 1875 included finds in both Imogene and Yankee Boy basins near the top of the Canyon Creek watershed (Montgomery Watson, 2001) and discoveries at the Camp Bird Mine in 1896 (Mindata.org, 2018) in the Sneffels District.

A gold rush to the Ouray area ensued the following spring and facilitated the surveying and incorporation of the town of Ouray on September 2, 1876. Since there was no rail service to the area, ore was transported by mule train to Silverton for processing. This limitation made it impractical to transport anything but the highest-grade ores. Initially, the richest discoveries were made in the Sneffels District, located immediately southwest of the Camp Bird mine. The Sneffels District included the mines situated in the Imogene, Governor, and Yankee Boy Basins inclusive of all mining activities in and around the town of Sneffels. The principal ore bearing deposits were discovered in the Sneffels District between 1875 and 1881 (Montgomery Watson, 2001).

The Atlas Mine, situated at the foot of Sidney Basin, was established around 1876. Instead of carrying the ore to Silverton for processing, the Atlas Mine transported its ore via an aerial tram to the Atlas Mill approximately 500 feet below the mine. During this time (1875-1891) the town of Sneffels surrounded the mill site with a peak population of about 2,000 people (Alpine Environmental Consultants LLC., 2018). Although the original mining claim was established in 1876, most of the ore processing likely occurred in the early 1900s (USFS, no date).

2.1.2 Site Characteristics

The Atlas Mill site features remnants of the historic mill structure on the hillside, an adjacent pile of coarse-grained waste rock, and fine-grained tailings on the floodplain adjacent to the western side of Sneffels Creek. Part of the Mill and adjacent waste rock are eligible for the National Historic Register. The site footprint is approximately 7.5 acres and is largely devoid of vegetation.

The tailings are partly located within the riparian wetland associated with Sneffels Creek. Ten seeps and springs were identified during the wetland delineation process, five of which exit from the bedrock below the mill adjacent to the waste rock pile, one from the floodplain at the northwest edge of the site, and four from the hillslope above the upper portion of the grey tailings (WestWater Engineering, 2015).

Prior to 2016, Sneffels Creek was actively eroding the Atlas Mill tailings in a braided section of the creek near the upstream portion of the Atlas Mill Site and creating a small wetland area along the braided channel. A bank stabilization project was completed in July 2016 to reduce the interaction between the creek and tailings. Partners in this project included the USFS, DRMS, OSMI, Western Stream Works, and UWP. The stabilization project directed flow through a single thread channel and minimized braiding on the upstream portion of the site. In October 2016, staff planted willow transplants and seeded within the riparian corridor. The stream work and subsequent vegetation plantings through this section have reduced overbank erosion in recent years, which has helped stabilize the upper portion of the site area.

2.1.3 Current Uses

Camp Bird Road (County Road 26/Forest Service Road 853) is especially busy with motorized recreation in the summer months. Private users and commercial jeep tours use the historic mining routes to travel through the sub-alpine and alpine areas to experience the natural beauty and historic mine relics, including the Atlas Mill. Visitors occasionally park along Camp Bird Road directly across from the site and cross Sneffels Creek, on foot, to access and view the historic Atlas Mill structure. Traffic count estimates for summer travel on the road range from 53,428 (June to Nov 2016) (USFS, 2017) to over 115,000 per year (Ouray County Traffic Dept. 2015 to 2018) with peaks of 15,000 to 27,000 per month during July to September.

In addition to recreational activity along Camp Bird Road, there is also active mining upstream and downstream of the site. The Ouray Silver Revenue-Virginius Mine is immediately downstream of the Atlas Mill (visible in the background of Figure 2.1). The Ruby Trust Mine is located approximately 0.25 miles upstream of the site.

2.1.4 Hydrology and Hydrogeology

2.1.4.1 Hydrology

Sneffels Creek runs adjacent to the eastern side of the Site, and drains into Canyon Creek, a tributary to the Uncompahgre River. Sneffels Creek is a snowmelt driven, single channel creek with moderate sinuosity, low entrenchment, and steep gradients. Based on stream flow data measured from 2012 to 2017, flow ranges from 3 cubic feet per second (cfs) during low flow to an estimated 150 cfs during peak runoff (Alpine Environmental Consultants LLC., 2018). There are no stream gauges on Sneffels or Canyon Creeks and no FEMA floodplain maps exist for this area.

In 2015, 6.56 acres of wetlands, classified as WOTUS, were identified in the surrounding area of Sneffels Creek. Approximately 5.70 acres are palustrine scrub-shrub, 0.66 acres are palustrine emergent, and 0.20 acre are riverine emergent. Of the established palustrine scrub-shrub wetlands, 3.6 acres are located in an upland area above the grey tailings and the majority of the remainder is on the opposite bank of Sneffels Creek or in the area of the site upstream of tailings. Of the 0.2 acres of riverine emergent wetlands, 0.12 acres were located in the former braided channel through tailings (eliminated in 2016). Between Sneffels Creek, high water side channels, intermittent tributaries (1,096 linear feet), and several spring and seep sources, approximately 3,827 linear feet of streambed was identified (WestWater Engineering, 2015), although 1,885 linear feet of high-water side channel was cut off by the 2016 stream channelization work. A further, in-depth investigation of the hydrology of the surrounding area and tributaries to the Site was completed as part of a study attached in Appendix C.

2.1.4.2 Hydrogeology

There are two aquifers in the region with water occurring in both the fractured bedrock and the Quaternary alluvium. The Quaternary alluvium is confined to the stream valley bottoms and the potentiometric surface encountered in these deposits most likely reflects the surrounding ground surface. The alluvial deposits in the area are thin and discontinuous. Water contained in the Quaternary deposits can also be a means of transmitting stream water to bedrock (Montgomery Watson, 2001).

2.1.5 Geology

The Canyon Creek Watershed is within the San Juan Mountains of southwest Colorado, which are characterized by rugged mountain peaks, steep drainages and long, narrow valleys (Gault Group, 2015). The San Juan Mountains in this area have a basement of Precambrian metamorphic rock overlain by Devonian to Jurassic sedimentary rocks and finally by Tertiary volcanics with associated mid-Tertiary andesitic volcanic intrusions. The Canyon Creek

Watershed is located outside the margin of the Silverton Caldera. The bedrock in the area consists of volcanic rocks that are complexly fractured, faulted and intruded by breccia pipes and veins (Montgomery Watson, 2001). Mineralized zones in the area consist of breccia pipe deposits and vein deposits that contain rich orebodies that have extractable quantities of several minerals, including gold, lead, silver, and copper (Nash, 2002). The Atlas Mine was developed on a silver-rich vein containing quartz, rhodochrosite, pyrite, galena, sphalerite, tennantite, and pearcite.

2.2 Source, Nature and Extent of Contamination

Identification of the source, nature and extent of contamination at the Site was based on a surface water and waste rock/tailings sampling program. The Colorado DRMS, the Water Quality Control Division (WQCD), and UWP collected data between 2012 and 2015 from six surface water locations and four sediment sample locations in the area surrounding the Site. From 2013 to 2015 the sampling was expanded to include high and low flow conditions (Alpine Environmental Consultants LLC., 2018).

OSMI also provided additional surface water quality data from 2011 to 2017. Extensive sediment borehole data were provided from the prior Revenue Virginius mine owner, Fortune Revenue Silver Mines as part of a feasibility study for reprocessing tailings and waste rock present on site.

2.2.1 Atlas Mill and Tailings

The Atlas Mill and tailings are located on an east-northeast facing slope in the Upper Uncompahgre River watershed, about a half-mile west of the former location of the town of Sneffels and the OSMI Revenue-Virginius Mine. This Site consists of waste rock near the mill structure and a tailings deposit on the floodplain that extends 1,000 feet along the western side of Sneffels Creek as generally shown in Figure 2.1. The total amount of tailings deposited in this area is estimated to be 24,000 cubic yards, and the amount of waste rock is estimated at 2,000 cubic yards (Montgomery Watson, 2001). Two types of mining-related sediment on the floodplain can be identified. The lower grey sediment is nearly-alkaline (pH 6.6) and non-acid forming, and the upper yellow sediment is acidic (pH 3.4) and oxidized (Jennings, 2014). Both types of tailings are fine-grained and highly susceptible to fluvial and aeolian transport (Jennings, 2014), which is why stabilization in-place and limiting migration off-site will be the goal of future removal actions. The mill structure is collapsing and poses a physical hazard, but is of historical significance (Montgomery Watson, 2001). The area around the mill site and tailings includes Engelmann spruce-alpine fir habitat and willow habitat along Sneffels Creek. Access to the mill is by a jeep road off Forest Road 853, which is popular for recreational uses (Gault Group, 2015).

Figure 2.1: Atlas Mill Tailings Adjacent to Sneffels Creek. The photo was taken near the mill structure and looking down-valley to the southeast. Photo credit: Agnieszka Przeszlowska (Shearwater LLC., 2018).

2.2.1.1 Surface Water Quality

Sneffels Creek is on the State of Colorado's 303(d) list for cadmium, lead, and zinc impairment of the aquatic life standards. Sneffels Creek also is on the 303(d) list for impairment of the manganese water supply standard (segment COGUUN05) and for failure to meet the macroinvertebrate criteria (WQCC, 2018). Sneffels Creek segment COGUUN05 is not currently used as a water supply but is listed as so per the Segment description. The primary metal sources are historic abandoned mine features and natural geologic sources (Alpine Environmental Consultants LLC., 2018).

Additional characterization of the Atlas Mill area for this EE/CA included collection of surface water samples in Sneffels Creek above and below the tailings area. These samples were collected to bracket the Atlas Mill area to allow evaluation of the contribution of the area to metals loading to Sneffels Creek. The approximate location where these samples were collected is shown on Figure 2.2. The segment of Sneffels Creek that flows along the Site is Segment COGUUN05, which is classified as agriculture, aquatic life cold 2, recreation E, and water supply. Downstream of the Site, Sneffels Creek transitions to Segment COGUUN09, which is classified as agriculture, aquatic life cold 2, and recreation E (Regulation #35, 5CCR-1002-35, Dec 2017). The primary difference between segments is the lack of drinking water standards in the downstream segment.

The analytical results from these samples are presented in Table 1. The Site does not cause an increase in total or dissolved arsenic concentrations from upstream to downstream of the Site (4.9 to 4.4 micrograms per liter (ug/L)). The Atlas Mill may cause a slight increase in dissolved cadmium, dissolved silver, and dissolved zinc concentrations in Sneffels Creek. The concentrations of cadmium and zinc in Sneffels Creek downstream of the Site frequently exceed

chronic aquatic life standards with occasional exceedances for lead and silver. Chronic aquatic life standards also are exceeded for cadmium and zinc, and occasionally lead upstream of the Site.

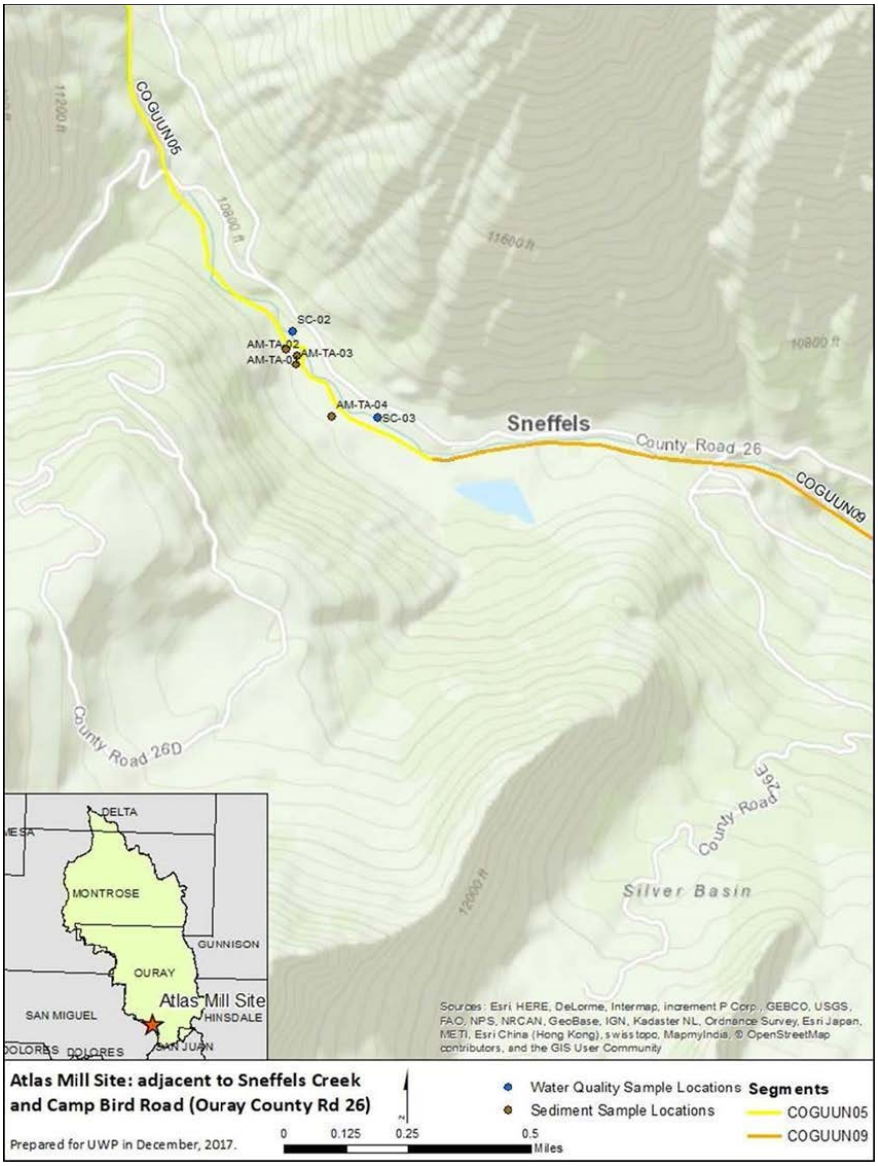


Figure 2.2: Water Quality and Sediment Sample Locations near the Site (Alpine Environmental Consultants LLC., 2018)

Table 1: Water Quality Standards Evaluation Upstream and Downstream of the Site (adopted from Alpine Environmental Consultants LLC., 2018)

Zone	Location	Statistic	Hardness (mg/L)	Total Arsenic (ug/L)[1]	Dissolved Arsenic (ug/L)	Dissolved Cadmium (ug/L)[2]	Dissolved Lead (ug/L)	Dissolved Mercury (ug/L)	Dissolved Silver (ug/L)	Dissolved Zinc (ug/L)
Sneffels Creek upstream of Atlas Mill Site (Segment COGUUN05)	SC-02	Result Count	8	8	8	8	8	8	8	8
		Minimum	38	1.3	0.42	0.15	0.17	<0.03	<0.12	52
		Mean	53	4.9	0.76	0.48	0.58	All results < MDL	All results < MDL	120
		85th Percentile[3]	NA							NA
		Maximum	70	15	1.2	0.92	0.99			220
		Chronic Standard[4]	NA	0.02	NA	0.44	0.94	0.01	0.026	68
		Count > Chronic		**0**		**5**	**1**	0	0	**6**
		Acute Standard		10	340	0.99	32.4	NA	0.71	90
		Count > Acute		**1**	0	**1**	0		0	**5**
Sneffels Creek downstream of Atlas Mill Site (Segment COGUUN09)	SC-03	Result Count	8	8	8	8	8	8	8	8
		Minimum	36	0.56	0.42	0.19	0.17	<0.03	<0.12	53
		Mean	53	4.4	0.78	0.54	0.58	All results < MDL	<0.12	125
		85th Percentile	NA						NA	
		Maximum	71	15	1.2	0.99	0.84		0.76	230
		Chronic Standard	NA	7.6	NA	0.44	0.81	0.01	0.026	68
		Count > Chronic		**1**		**5**	**1**	0	**1**	**6**
		Acute Standard		NA	340	0.99	32.2	NA	0.92	90
		Count > Acute			0	**1**	0		0	**5**

Notes:

1. Segment COGUUN05 has a water supply designation which includes a two-part standard for arsenic. 0.02 ug/L is applied as a human-health standard and 10 ug/L is the maximum contaminant level (MCL) for water supply. The segment is considered in attainment of the water supply standard if arsenic concentrations are < 10 ug/L. Segment COGUUN05 also has a water + fish arsenic standard of 0.02 ug/L. The water + fish standard was not evaluated in this assessment. Official standards evaluations are completed by the WQCD and published in Regulation 93.
2. Segments COGUUNO5 and COGUUN09 have site-specific equations for cadmium as specified in Colorado WQCC Regulation 35 effective date 12-31-2017.
3. Percentiles were not calculated at locations with fewer than 10 samples.
4. For locations with fewer than 10 samples, a paired standards evaluation was completed. Where fewer than 10 samples were collected the table reports the average standard calculated for each result pair and the number of exceedances. For locations with ten or more samples, the mean hardness was used to calculate the standard. The 85th and 95th percentiles were compared to the chronic and acute standards, respectively.
5. Bold numbers represent stream values that exceed the in-stream water quality standards

2.2.1.2 Tailings and Waste Rock

Samples of the tailings and waste rock from the Site were collected in 2012 to evaluate the leachable metals from these samples using EPA Method 1311 extraction procedure, otherwise known as the toxicity characteristic leaching procedure (TCLP). The filtrate was analyzed for metal concentration using mass spectrometry (ICP-MS/ICP-AAS, EPA Methods 200.7/200.8) and the results are seen in Table 2 (Alpine Environmental Consultants LLC., 2018). The first two samples (TA-01 and TA-02) appear to be from the yellow tailings and the last two samples (TA-03 and TA-04) appear to be from the grey tailings. Arsenic concentrations range from 0.02 to 0.08 ug/L, cadmium concentrations range from 1.3 to 13.0 ug/L, copper concentrations ranged from 1 to 65 ug/L, lead concentration range from 290 to 3,500 ug/L, and zinc concentrations range from 200 to 3,100 ug/L (Table 2).

Table 2. TCLP Leachate Analysis of Tailings (adopted from Alpine Environmental Consultants LLC., 2018).

Sample Location	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
				ug/L			
AM TA-01	0.04	7.3	65	3,500	<0.001	<0.02	1,700
AM TA-02	0.02	6.1	30	2,700	<0.001	0.02	1,400
AM TA-03	0.08	1.3	1	290	<0.001	0.04	200
AM TA-04	0.03	13.0	44	690	<0.001	<0.02	3,100

Based on the sediment leachate metal concentrations, the tailings at the Atlas Mill have the potential to increase metal concentrations in surface waters that infiltrate through the tailings. This is because the metal leachate concentrations, particularly cadmium, lead, and zinc, in the tailings are greater than the concentrations measured in Sneffels Creek. Therefore, preventing metals leaching to receiving surface waters through in-situ stabilization would align with potential removal action objectives. While these TCLP results show the potential for increases to adjacent surface water concentrations, all results fall below the hazardous waste designations associated with the Resource Conservation and Recovery Act (RCRA) eight heavy metals. These eight metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag) are compared to EPA allowable limits, and then deemed hazardous or non-hazardous. None of the TCLP results listed above for any of the metals exceed RCRA levels, therefore the material is not considered hazardous with regards to disposal fate and location of appropriate landfills.

Four sediment samples from the tailings (0 to 6-inch depth) also were selected following an informal X-Ray fluorescence (XRF) survey. Results are presented in Table 3.

Table 3. XRF Analysis of Grey and Yellow Tailings (adopted from Alpine Environmental Consultants LLC., 2018).

Total Metal concentrations measured by XRF (mg/kg)									
Sample Location	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Silver	Sulfur	Zinc
Atlas Mill Site #5 (grey)	29	18	172	9,480	2,512	2,181	86	6,587	4,307
Atlas Mill Site #7 (yellow)	149	ND	60	9,404	3,675	192	96	5,959	177

The yellow tailings have higher concentrations of arsenic, lead, and silver than the grey tailings, while the grey tailings have higher concentrations of cadmium, copper, manganese, sulfur and zinc. It should be noted that these results were performed with an XRF in the field and can differ from actual lab results. However, they provide a good representation of actual Site conditions as they fall in between the ranges observed during the borehole study discussed below.

2.2.1.3 Borehole Sediment Samples

In addition to surface water and soil samples, a prior mine owner collected sediment borehole data of the tailings to assess the feasibility of re-processing the Atlas Mill tailings. About 267 samples were collected between 2012 and 2014 from 0.3 to 10 feet depth and analyzed for lead, copper, and zinc using a total constituent analysis (TCA) (Figure 2.3).

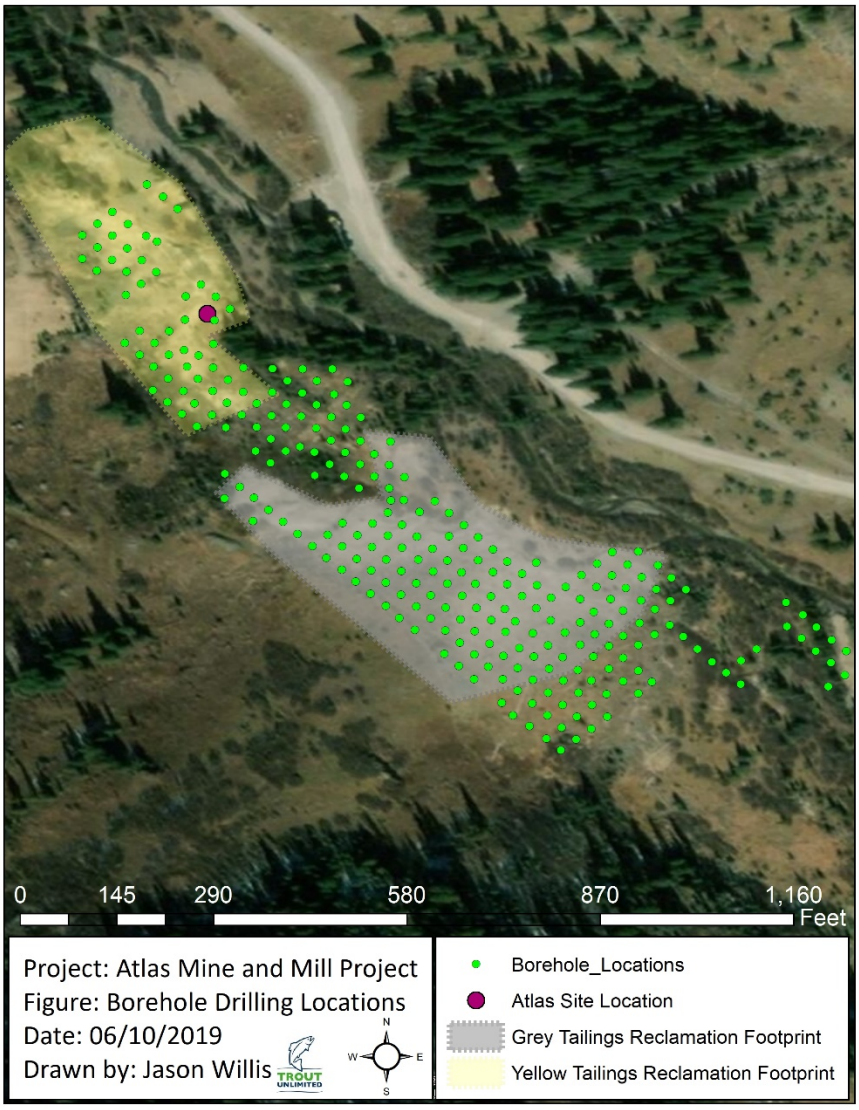


Figure 2.3: Locations of borehole sampling event that took place between 2012 and 2014. 267 samples were taken between depths of 0.3 to 10 feet.

Copper concentrations ranged from 0 to 1,000 milligrams per kilogram (mg/kg). Lead concentrations ranged from 1,100 to 14,700 mg/kg. Zinc concentrations ranged from 300 to 21,000 mg/kg (Table 4).

Table 4: Borehole sampling summary of Pb, Cu, and Zn concentrations observed during the analysis. Maximum, minimum, and average values are shown within the table for reference in comparison to XRF values found on site.

Borehole Sampling Summary	Pb (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
MAX	14700	1000	21000
MIN	1100	0	300
Average	4677	351	5640

2.3 Ecological and Human Health Risk

There is limited data available to complete a detailed human health and ecological risk assessment for the Site. Therefore, any improvements to human and ecological health will be a secondary benefit to the overall removal action goal of mitigating the migration of contaminated material off-site. The sediment data that is available was measured using XRF and TCLP methods. Therefore, comparing these values to published soil screening levels may not be consistent with typical risk assessment procedures. Despite this limitation, results from the samples of tailings collected in boreholes by the former mine owner were evaluated against soil screening levels (SLs) developed to evaluate risk associated with historic abandoned mine sites (CH2M Hill, 2015) to assess whether concentrations in sediments were likely to exceed soil screening levels. The screening levels for both human health and ecological risk are provided in Tables 5 and 6 below. It should be noted that levels in these reports have since been updated by the Bureau of Land Management (BLM) for 14/days/year camping limits. Table 5 and 6 values are maintained in this analysis as a reference from the previous report completed by Alpine Environmental Consultants. Based on this evaluation, in its 2018 Assessment Report, UWP concluded that lead concentrations in the tailings posed a risk to human health by exceeding the human health SL of 1,000 mg/kg. Concentrations of cadmium, lead, and zinc in the borehole tailings results shown in Table 4 posed a risk to ecological receptors by exceeding the corresponding SLs of 0.99 mg/kg, 36 mg/kg, and 121 mg/kg, respectively. (Alpine Environmental Consultants LLC., 2018).

Table 5: Soil Screening Levels to Assess Potential Human Health Risks (Alpine Environmental Consultants LLC, 2018)

Contaminant of Concern	Concentration in Soil (mg/kg)[1]	Basis[2]
Arsenic	54	10×10^{-6} cancer risk
Cadmium	18,000	HQ=1
Lead[3]	1,000	HQ=1
Mercury	6,300	HQ=1
Silver	104,000	HQ=1
Zinc	> 1,000,000	HQ=1

Notes:

1. Screening criteria adapted from "Workplan for Screening Potential Risks Associated with Historic Mine Sites on Bureau of Land Management Land" CH2MHill, April 2015. Total recoverable concentrations per the methods presented in the document.
2. Soil screening levels were developed using a recreation scenario that assumes an individual is potentially exposed for 14 days per year over 30 years. The basis provides the metal concentrations in soil based on the lower of a target lifetime cancer risk of 1 x 10-6 or a noncancer Hazard Quotient (HQ) of 1.
3. Lead screening level adapted from "Risk Management Criteria for Metals at BLM Mining Sites" BLM October, 2004. Screening level criteria for a camper.

Table 6: Soil Screening Levels to Assess Potential Ecological Risks (Alpine Environmental Consultants LLC, 2018)

Contaminant of Concern	Concentration in Soil (mg/kg)[1,2]
Arsenic	9.8
Cadmium	0.99
Lead	36
Mercury	0.18
Silver	2.0
Zinc	121

Notes:

1. Source for screening levels: USEPA. 2005. Guidance for Developing Ecological Soil Screening Levels, Office of Solid waste and Emergency Response, Directive 92857.7-55, Washington, D.C.,

2. The concentrations provided are solely for screening purposes. In particular, mercury is known to bioaccumulate in food chains, thus other site-specific values may be more appropriate.

Results of this evaluation are presented in Table 7 below (Alpine Environmental Consultants LLC., 2018).

Table 7: Risk Assessment Results for Borehole Sediment Samples Collected Throughout the Tailings (adopted from Alpine Environmental Consultants LLC., 2018).

Human Health Screening	Copper	Lead	Zinc
Samples > Risk Level	0	267	0
Total Samples	267	267	267
Percent samples > Risk Level	0%	100%	0%
Ecological Receptors	**Copper**	**Lead**	**Zinc**
Samples > Risk Level	265	267	267
Total Samples	267	267	267
Percent samples > Risk Level	99%	100%	100%

As identified in Table 7, all 267 borehole samples exceeded human health risk screening concentrations for lead and exceeded ecological receptors screenings for lead and zinc. Approximately 99% of borehole samples also exceeded ecological receptors screenings for cadmium. For example, lead concentrations in the sediments were more than three times the

human health soils screening level (e.g., 3675 mg/kg compared with 1000 mg/kg). With regards to ecological risks, cadmium concentrations in the sediments were more than 18 times higher than the screening levels (18 mg/kg versus 0.99 mg/kg). Lead concentrations were 100 times greater than the ecological screening levels (3675 mg/kg compared with 36 mg/kg). Lastly zinc concentrations in the sediments were 35 times greater than soil screening levels (4307 mg/kg versus 121 mg/kg).

Due to the overlying contaminated material, there is also the potential for groundwater impacts due to the presence of seeps and springs on the Site, thus indicating shallow depth to groundwater. Addressing the tailings at the Site through this removal action will help mitigate potential pathways of exposure and will help reduce the risk to human health and environment as a secondary benefit of the main removal action goal.

2.3.1 Additional Screening Level Risk Assessment

To further investigate the risk level and relation to site conditions, the following assessment was done comparing field XRF data from Table 3, as well as borehole data from Table 4 to BLM human health recreational visitor screening levels.

During recent EE/CAs and site investigative studies, TU and USFS have compared soil concentrations to Bureau of Land Management (BLM) recreational screening levels (SLs) issued per a 2017 guidance/memo. The XRF data from Table 3 shows that the yellow tails exceed the arsenic and lead SLs, while the grey exceed only the lead. No other metals exceed Recreational SLs. The lead exceedances are only an order of magnitude higher than SLs, wheras many mineralized areas and mine sites in the Silverton Caldera have lead levels in excess of 15,000 mg/kg or 2 orders of magnitude above SLs. The borehole sample data presented in Table 4 align with UWP findings in the Atlas Mill Assessment report presented in the above section. This data shows that all lead concentrations from the borehole study exceed BLM Recreational SLs. The average lead values from the borehole data are an order of magnitude above the SL.

From the evaluation of data in the previous sections, it seems that ecological risks to the four receptor groups (birds, insects, mammals, plants) are the primary drivers at the site due to the large exceedances. While lead concentrations do exceed Recreational SLs, institutional controls such as disallowing camping on-site and signage will limit human exposure and invalidate the 14-day exposure assumption used in screening level calculations. Institutional controls will also be incorporated to the selected Alternative to educate visitors about potential contamination present on reclaimed surfaces. It will be the goal of the USFS and project partners to stabilize tailings/waste in-place, while reducing migration of material off-site and downstream. Preventing metals leaching through surface or groundwater pathways via the recommended removal action alternative will be another secondary benefit of the project to help reduce metals loading downstream.

Table 8: Human Health Screening Levels (SLs) for Chemicals in Soil At BLM HazMat/AML Sites (mg/kg)

Chemical	BLM Recreational SL	EPA Residential SL	EPA Industrial SL
Aluminum (Al)	>1,000,000	77,000	>1,000,000
Antimony (Sb)	782	31	470
Arsenic (As)	30.6	0.68	3
Barium (Ba)	390,000	15,000	220,000
Beryllium (Be)	3,910	160	2,300
Cadmium (Cd)	1,780	71	980
Chromium (III) (Cr)	>1,000,000	120,000	>1,000,000
Cobalt (Co)	586	23	350
Copper (Cu)	78,200	3,100	47,000
Iron (Fe)	>1,000,000	55,000	820,000
Lead (Pb)	800[a]	400	800
Manganese (Mn)	46,700	1,800	26,000
Mercury (elemental) (Hg)[b]	271	11	46
Molybdenum (Mo)	9,780	390	5,800
Nickel (Ni)	39,000	1,500	22,000
Selenium (Se)	9,780	390	5,800
Silver (Ag)	9,780	390	5,800
Thallium (Tl)	19.6	0.78	12
Uranium (U)[c]	391	16	230
Vanadium (V)	9,850	390	5,800
Zinc (Zn)	587,000	23,000	350,000
Primary Exposure Assumptions	14 days/year, 26 years, adult/child	350 days/year, 26 years, adult/child	225 days/year, 25 years, adult

2.4 Conceptual Site Model

As part of the 2018 Assessment Report, UWP also completed a CSM to identify potential pathways for soil, surface water, groundwater and air migration. These pathways were evaluated as potential routes for human health and ecological exposures and associated risk. A copy of the CSM developed by UWP is provided below in Figure 2.4, which shows complete exposure pathways to mill tailings through erosion for the recreational user, ecological receptors, and aquatic life populations. It also showed complete exposure pathways to waste rock through direct contact and sediment erosion to the recreational user and ecological receptors, and partial exposure pathways to waste rock and mill tailings through sediment, surface water and groundwater. Lastly, a complete exposure pathway to mill tailings from stormwater runoff to aquatic life also is demonstrated by the CSM.

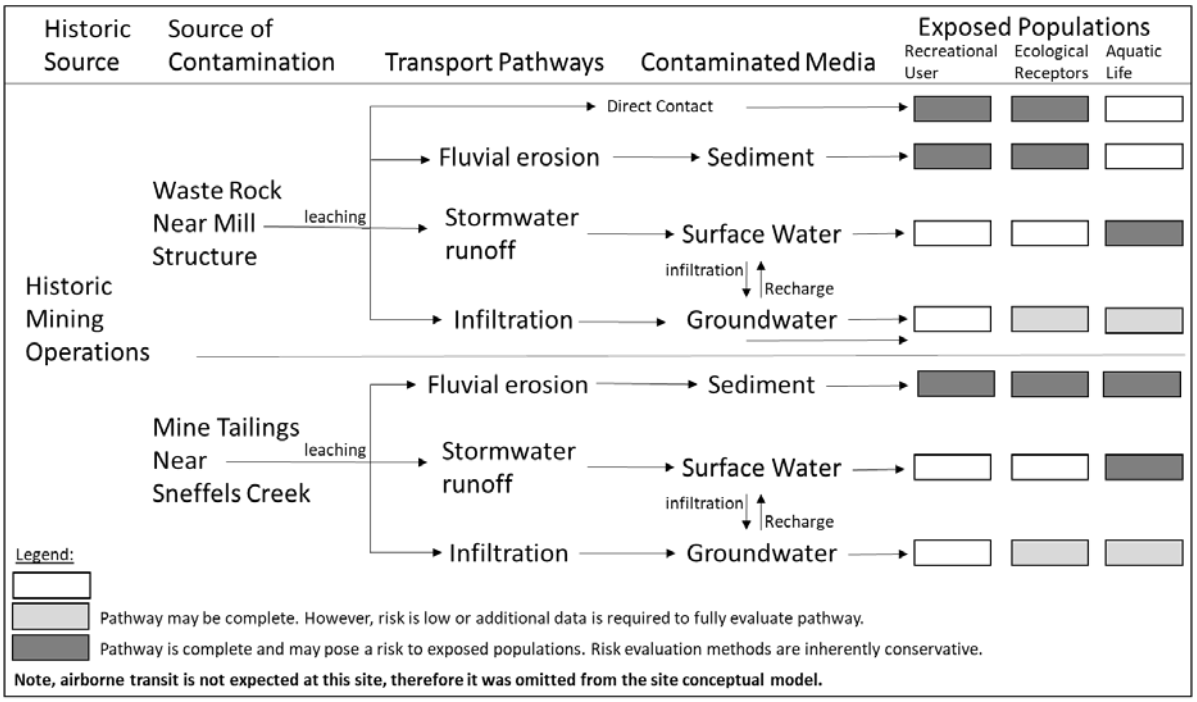


Figure 2.4: Conceptual Site Model (Alpine Environmental Consultants LLC., 2018)

While the CSM shows potential effects to Recreational users at the site through contaminated sediment sources and direct contact with waste rock, it will not be the focus of the removal action due to the limited exposure and restrictions of access to the Site. Mitigating Recreational user exposure is outside the scope of future removal actions, which will focus on stabilizing contaminated material on-site with the goal of minimizing off-site mobilization. Through these stabilization efforts, the main goal will correspond to preventing metals leaching to receiving off-site sources. The exposed populations of ecological receptors and aquatic life will see the most benefit through these efforts.

2.5 Land Ownership

The Site is comprised of claims owned by both the USFS and OSMI. The Atlas Mill project area is roughly 8.8 acres with approximately 5.08 acres of USFS property and 3.71 acres on patented claims owned by OSMI. The parcels mentioned below in ownership of USFS were re-acquired patented claims in a lands action/acquisition in 2001 from the Trust for Public Lands, once again making these National Forest System managed lands, and no longer privately owned.

A land survey was completed by OSMI and reviewed by the USFS. A list of the Claims associated with the Site is provided in Table 9.

Table 9: Property Ownership by Claim Name

Claim Name	Ownership	Parcel ID
Chattahoochie MS	USFS	17238B
Gilpin County MS	USFS	2471
Canadian Boy MS	USFS	13281
Dobson MS	USFS	2470
Zig Zag MS	USFS	17580B
Lincoln MS	Ouray Silver	7284B
Egypt Placer	Ouray Silver	16053
Grant MS	Ouray Silver	7284
Valley View	Ouray Silver	1823

Figure 2.5 shows the approximate location of the Site in relation to the ownership boundaries of the claims listed above. Generally speaking, the waste rock pile and grey tailings and a portion of the yellow tailings are located on USFS claims and a larger portion of the yellow tailings and Sneffels Creek are located on Ouray Silver Mine's claims. As part of this process, OSMI is working in partnership with the USFS to address impacts from the Atlas Mill across ownership boundaries via a non-time critical removal action that will follow this EE/CA.

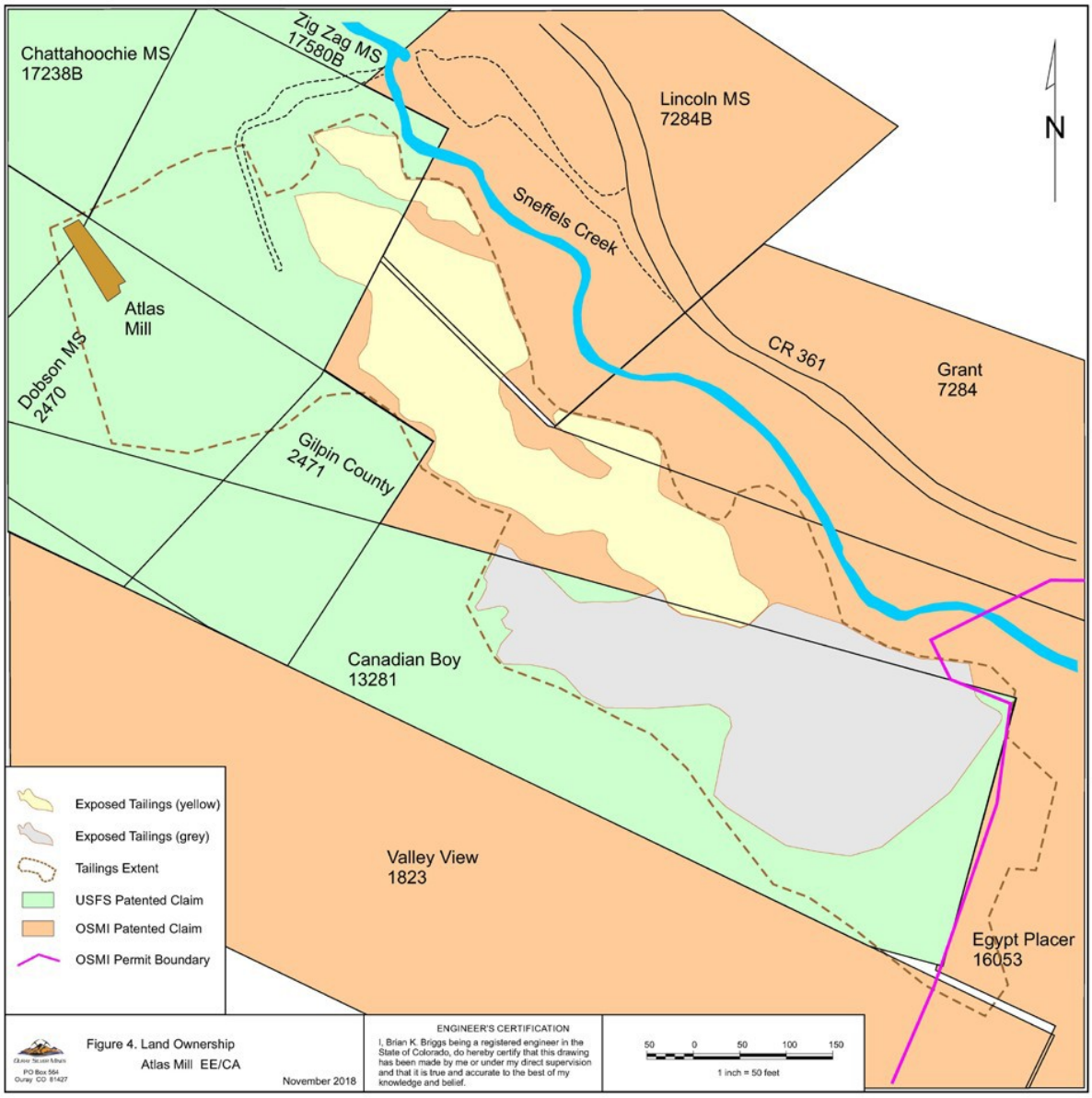


Figure 2.5: Land Ownership Map courtesy of Ouray Silver Mines Inc. (OSMI)

3.1 REMOVAL ACTION GOALS AND DOCUMENTATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

3.1 Removal Action Scope and Goals

The scope of the EE/CA includes identification and evaluation of Removal Action Goals for the Site.

3.1.1 Removal Action Goals

Removal action alternatives for this Site were developed for two of the eight removal factors:

- IV – High levels of hazardous substances, pollutants, or contaminants in surface soils that may migrate.
- V – Weather conditions (avalanches) may cause hazardous substance or pollutants/contaminants to migrate or be released.

By completing removal actions that focus on the above factors, partners anticipate the following added benefits and goals while preventing contaminants from migrating off-site.

- Stabilization of contaminated material on-site while reducing ability of that material to migrate or be mobilized off-site;
- improve water quality in Sneffels Creek;
- reduce potential risks to the environment (ecological and aquatic receptors) from exposure to mill tailings and other mine wastes at the Site;
- control runoff from mine waste and minimize erosion of historic mill tailings; and
- stabilize the streambank along appropriate reaches of Sneffels Creek to prevent erosion of tailings during high flow conditions.

3.1.2 Removal Action Justification

In accordance with 40 CFR 300.415(b)(2), a Non-time Critical Removal Action is justified if there is a threat to human health or the environment based on one or a combination of any of the eight factors listed below in Table 8.

Table 10: Removal Action Justification Factors per CERCLA Section 40 CFR 300.415(b)(2)

Factor	Site Condition	Justified
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants.	Limited public access to historic mill tailings, soils and surface water containing elevated concentrations of metals exists. Wildlife populations also have access to tailings and other mine waste as well as surface flows.	Yes
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems.	Sneffels Creek is a tributary to the Uncompahgre River, which is a source of drinking water for several communities downstream.	Yes
(3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.	No drums, barrels, tanks, or bulk storage containers on the Site.	No
(4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface, that may migrate.	Concentrations of metals in historic tailings and waste rock piles are subject to erosion and migration.	Yes
(5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released.	Sediment subject to erosion during wind, high flows, rain events, and snowmelt could cause waste material migration.	Yes
(6) Threat of fire or explosion.	No flammable materials on the Site.	No
(7) The availability of other appropriate federal or state response mechanisms to respond to the release.	The Site is on both private and USFS-administered land.	Yes
(8) Other situations or factors that may pose threats to public health or the environment.	There are historic mill structures that pose a potential physical hazard to the public.	Yes

**** Factors 1, 2, 4, and 5 are the most applicable to conditions present at the Atlas Mine/Mill Site. This removal action will focus on Factor 4 responses that will stabilize hazardous substances in soils while also mitigating off-site migration.**

3.2 Applicable or Relevant and Appropriate Requirements

Section 300.415(j) of the National Contingency Plan (NCP) requires that removal actions pursuant to CERCLA Section 106 "shall, to the extent practicable, considering the exigencies of the situation, attain ARARs under federal environmental or state environmental or facility siting laws." The ARARs that have been identified for the Site are provided in Appendix A.

3.3 Non-Time Critical Removal Action

Based on discussions with TU, OSMI and the USFS, a non-time critical removal action is appropriate for the Site. After acceptance of this EE/CA and recommended alternative, the USFS will complete an Action Memorandum for the selected alternative through the established non-funded challenge cost-share (CCS) agreement (19-PA-11020400-020) between USFS and TU. Funding for the removal action has already been secured through the use of State of Colorado SEP funds and in-kind contributions from OSMI. Work on this removal action will be performed in accordance with the NCP and at the direction of an On-scene coordinator (OSC). Partnership with TU, USFS, EPA, DRMS, UWP and OSMI will continue throughout all phases of the project.

4.0 IDENTIFICATION AND EXPLANATION OF REMOVAL ACTION ALTERNATIVES

This Section presents several alternatives for addressing the Atlas Mill tailings and impacts to water quality and ecological receptors at the Site and evaluates each alternative with respect to its overall effectiveness in achieving the Removal Action Goals presented in Section 3.1, its implementability with respect to specific conditions at the Site, and the estimated cost associated with implementation. Cost estimates are provided in Appendix B.

Environmental impacts and risks from the Site include:

- Erosion/migration of contaminated tailings and waste rock off-site
- Seeps from or in the vicinity of waste rock and tailings that could add to contamination
- Ecological and aquatic receptor group contact with tailings/waste rock

The Atlas Mill building also presents a physical hazard due to it deteriorated condition, but due to its historical significance and eligibility for inclusion on the historical register, it will be left in its current condition and will not be discussed further as part of the removal action alternatives evaluated in this EE/CA. As part of the subsequent planning phases, USFS and partners will conduct necessary State Historical Preservation Office (SHPO) 106 consultation actions. The goal of future construction and removal actions will be to pose a "no adverse effect" to any historical features within the site footprint.

4.1 Alternative 1: No Action

No action is included in the EE/CA to serve as a baseline alternative for comparison of other alternatives. This alternative includes limited signage to advise visitors of the potential hazards of the tailings and waste rock piles. Additional signage would be placed near the mill structure to deter access to the building.

This alternative does not meet Removal Action Goals and as such is determined to have a low effectiveness. Under this option, the potential for erosion of tailings and waste rock into Sneffels Creek will continue and impacted groundwater, if any, seeping from the tailings, will continue to potentially impact the creek. Ecological and aquatic receptor groups will also continue to be affected via this Alternative.

This alternative is highly implementable and the total cost of this alternative is approximately $5,000 for signage as shown in Appendix B.

4.2 Alternative 2: Cover of Exposed Tailings and Waste Rock

This alternative includes management of exposed tailings (4.0 acres) by grading to increase runoff and decrease infiltration, covering and revegetating to isolate from human contact and to further reduce infiltration and improve Site aesthetics.

This alternative also includes management of the waste rock area (0.6 acres) by installing a geosynthetic cover (due to greater than 3:1 slope) and establishing run-on and run-off controls to capture stormwater and snowmelt. A sedimentation pond on OSMI property will allow for settling of solids during runoff and periodic overflow events. This will attenuate flows before allowing them to infiltrate into on-site soils.

This alternative does not include further stabilization of Sneffels Creek.

This alternative combined with signage around the mill structure will meet Removal Action Goals with medium to high effectiveness. Management of exposed tailings and waste rock areas will minimize erosion into Sneffels Creek, as well as reducing infiltration to soils and groundwater. Revegetating the tailings, and covering the waste rock, will reduce the potential for human or other ecological receptor groups.

This alternative has medium to high effectiveness as many of the un-exposed tailings are located within the riparian areas of the Site and removing them to a new location on-Site could disturb sensitive wetland areas. Covering and revegetating the exposed tailings should have high effectiveness in terms of reduced runoff and infiltration. Covering the waste rock area will have high effectiveness in reducing impacts to Sneffels Creek and exposure to human and ecological receptor group contact. However, this Alternative is not recommended due to the amount of clean fill that would have to be generated on-site or brought in from outside the watershed. The amount of truck traffic required to haul clean-fill to the site would be prohibitive from a human safety perspective due to the large amount of recreational users during the time of construction. In addition to the amount of hauling necessary to provide enough of a cap, the underlying issue of water soluble metals and exposure of the ecological communities would not be addressed with just capping material. The addition of amendments in combination with a cap in Alternative 3 would help sequester heavy metals present in the mine waste and tailings.

The total cost for this alternative is estimated to be $681,240, not including a (-30%/+50%) contingency for the current level of conceptual design. Maintenance and upkeep of the tailings and waste rock areas are expected to add approximately $10,000/year to the total costs. Maintenance would be required for approximately three years until vegetation is established. Cost estimates for Alternative 2 are shown in Appendix B.

4.3 Alternative 3: Tailings Grading and Revegetation, Waste Rock Surface Water Controls, and Stream Bank Stabilization

Alternative 3 involves a variety of source area controls, drainage controls, and stream bank stabilization, which include:

Waste Rock Area (0.6 acres) run-on and run-off controls (swales) to capture stormwater and snowmelt (Figure 4.2). A set of two drainage fans will allow for settling of solids or sediment during runoff events before vegetation has a chance to establish (Figure 4.1). These channel features will be located on OSMI property and positioned at the end of the swales as shown in the photo below. The width of these features becomes approximately double the width of the incoming channel to allow for flow attenuation and deposition of sediment. The general goal of the swales and drainage fans is to control and convey clean water runoff during rainfall or snowmelt events after the site is reclaimed. Once vegetation has had time to establish post-reclamation, these features should not require much maintenance. These two drainage fans will be located at two approximate locations on OSMI property near the base of the Atlas Mill and along a run-off channel that will be located at the base of the current grey tailings area. Both of these features will focus on dissipating flow velocities into existing vegetation, or constructed wetland-type features with a heavy emphasis on willow transplants.

Figure 4.1*:* Example of a rock lined drainage fan and channel at another high altitude mine site in Colorado. The increased width of the feature will help dissipate storm flows before allowing to naturally runoff to existing vegetation.

Figure 4.2: Locally harvested rock lined run-on/run-off channel at a high altitude mine site. A smaller version of this swale would capture intermittent run-off adjacent the Atlas Mill and help convey off-site.

Sneffels Creek stabilization will be addressed in two reaches, and consist of excavation of bank sediment, boulder toe installation, and planting of willows and riparian shrubs/sedges to reduce erosion;

a. In Reach 1 (approximately 150 linear feet) the banks will be stabilized due to: relatively high gradient, sharp bend in stream, within 100 feet of historical tailings, and within 250 feet of Forest Service claims.
b. In Reach 2 (approximately 300 linear feet) the banks will be stabilized due to: relatively high gradient, sharp bend in stream, immediately adjacent to historical tailings, and within 50 feet of Forest Service claims. In addition, along 200 feet on the south side of the Reach, tailings will be removed up to 20 feet from the edge of the high-water mark of the stream channel. All tailings to be removed as part of this process will be consolidated with other tailings and waste rock material in the uplands portion of the Site. This material will be mixed, graded, and amended as part of the reclamation process listed in step five below.

The total aerial extent of tailings and waste rock on site is approximately 4.0 acres and is divided into “yellow” and “grey” tailings areas (Figure 4.3).

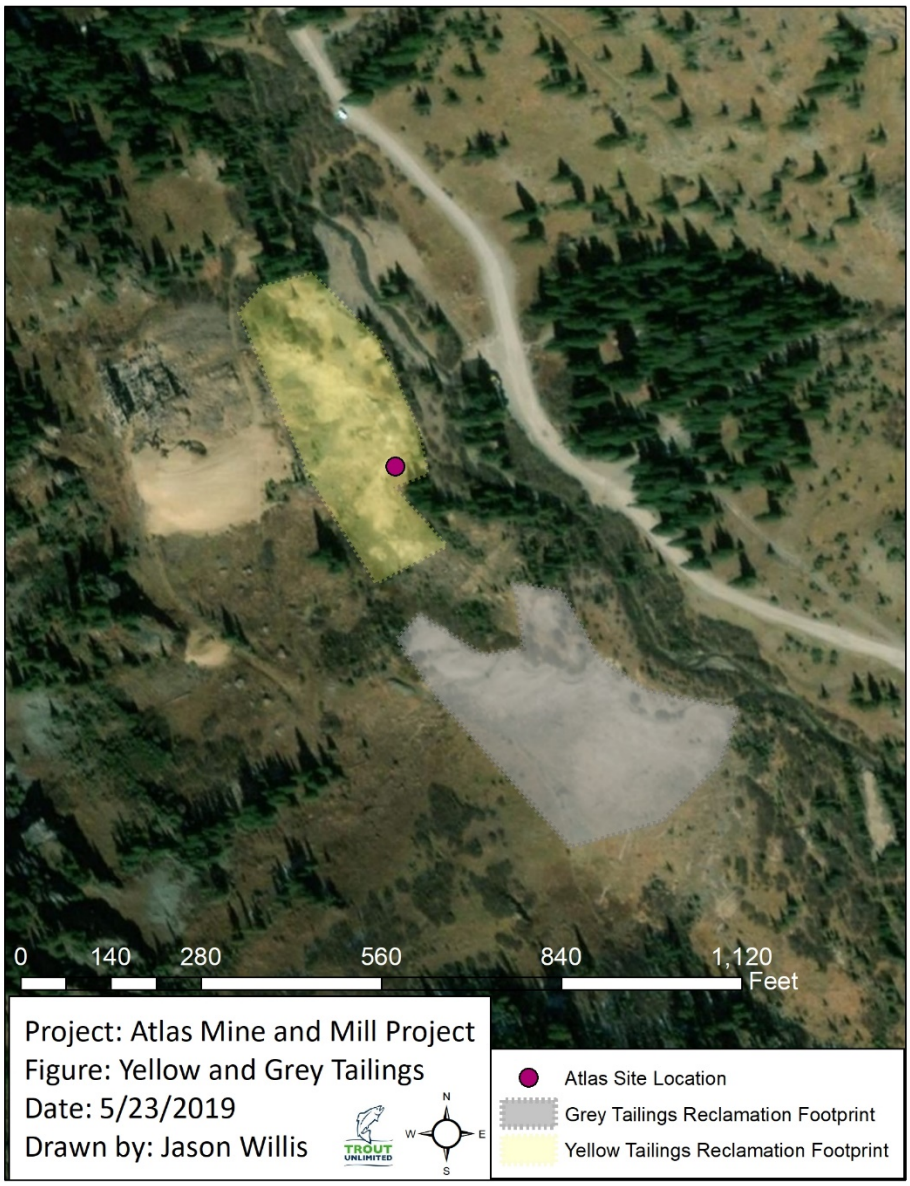


Figure 4.3: Approximate footprints of yellow and grey tailings areas, which total 4.0 acres. During the stabilization and treatment process, any wastes in the floodplain will be excavated and mixed with other wastes for in-situ treatment.

Per a flood study that will be included in a subsequent design phase, the exposed extent of tailings that would be in the active floodplain, will be excavated and consolidated with other waste material. The removed material will be placed with other yellow or grey tailings out of the floodplain. Removed waste material will be replaced and re-graded with locally harvested clean fill. Steep sections of the grey tailings will be re-graded to lessen the existing steep slopes to no more than 3:1 prior to treatment. Once tailings and waste material in the yellow and grey areas has been consolidated and re-graded, calculated amounts of amendments will be brought in to stabilize existing soils. The first step will be to neutralize acidic wastes with lime/limestone by tilling to depths of 12-16 inches, followed by incorporation of compost and fertilizer to add nutrients to the

poor soil. During the mixing process, the surface will be roughened and hummocked to dissipate surface velocities and create micro communities that will promote vegetation growth. Once amendments have been effectively mixed in and roughly graded to reduce sheet flow, native seed will be spread along with a mixture of 60/40 weed-free agricultural and wood straw. Following re-vegetation, appropriate zones of the yellow and grey areas will be lined with riparian shrubs or willow transplants on the northern toe facing Sneffels Creek. Biodegradable erosion control mats will also be installed on the edges of newly graded steeper banks to promote stability and allow native vegetation time to establish. The combination of these revegetation steps will help eliminate the migration of contaminated material off-site.

This alternative is highly implementable and will meet Removal Action Goals with moderate to high effectiveness and may be completed in phases as funding sources are available. This Alternative addresses the human health exposure risk by sequestering metals with limestone, organic amendments, and then capping the amended waste with clean-fill. Not only does this make the heavy metals contained in the waste unavailable to the ecological community through metals sequestration, it also provides a physical barrier to recreational visitors at the site through the clean-fill. It is also a more economical option when compared to Alternative 2 because less imported clean-fill will be required.

The total cost for this alternative is moderate and estimated to be $300,831, not including a (-30%/+50%) contingency for the current level of conceptual design. Maintenance and upkeep of the tailings and waste rock areas are expected to add approximately $10,000/year to the total costs. Maintenance would be required for approximately three years until vegetation is established and would include spot treatments with amendments and native seed. Costs estimates for Alternative 3 are shown in Appendix B.

4.4 Alternative 4: Offsite Disposal

Offsite disposal includes the excavation of the tailings and waste rock and disposal at an offsite disposal facility. Since tailings and waste rock TCLP results do no exceed the RCRA 8 levels for hazardous material, a normal landfill can be utilized for disposal. The Montrose County Landfill is approximately 50 miles north of the site and would require a 2.5 hour haul time one-way. This hauling distance, tipping fees, and sheer quantity of material will result in a large overall cost for implementation.

Disturbed soils remaining in the removal area would be revegetated following removal of the waste material by replacing with a combination of clean-fill generated on-site and from a suitable off-site facility. Following the placement and grading of clean-fill, revegetation similar to Alternative 2 actions would be utilized.

Offsite disposal along with signage around the mill building will meet Removal Action Goals

with high effectiveness. Removal of the tailings and waste rock would eliminate any chance of erosion of the waste materials as well as human/animal contact.

The total cost for this alternative is $4,093,450 due to the hauling costs and necessary truck trips to complete removal. This does not include backfill materials which may be necessary to properly regrade areas post removal activities. The operation and maintenance costs for the offsite disposal is minimal with the exception of maintaining vegetation established on regraded areas.

4.5 Alternative 5: Repository Construction

Consolidation of tailings and waste material into an on-site repository should also be considered as an option to mitigate contamination and exposure pathways to ecological and human health. This Alternative differs from Alternative 2 in that tailings and wastes would actually be excavated and placed into a constructed repository rather than covered in place with a geosynthetic liner and clean fill.

Construction of this Alternative would involve excavating yellow and grey wastes to depths of up to two feet, or the extent of contamination. The estimate of wastes to be moved into the repository based on the two-foot depth is 14,200 cubic yards (CY). Excavated wastes would then be hauled upslope, out of the floodplain, and placed into a constructed repository with a footprint of one acre, minimum (Figure 4.4). During construction of the repository, clean-fill would be generated, separated from larger rock, and staged adjacent to the repository. Due to the shallow bedrock and underlying geology of the area, approximately 810 CY of clean-fill or cover material would have be imported from Whitewater Building Materials in Telluride, CO. This extra material would provide enough cover depth for the material being removed from yellow and grey areas, as well as for an appropriate cap of the repository.

Figure 4.4: Approximate location of on-site repository and its footprint of 1 acre near the grey tailings area on the Canadian Boy USFS claim. The repository location should be an adequate location up out of the floodplain, while also away from historic features on site.

Excavated tailings and wastes would be placed into the constructed repository via compacted one-foot soil lifts to allow for maximum capacity (Figure 4.5). Following placement of wastes, staged clean-fill would be utilized to fill excavated areas of waste and tailings. Fill

Figure 4.5: Repository construction showing placement of contaminated material in one-foot lifts similar to the proposed actions for Atlas Site. The actions taking place in the photo were also at a USFS site near Boulder where a repository was partially used for mitigation of on-site material.

material would be graded to previously existing contours, roughened, and revegetated using a combination of fertilizer, compost, native seed, and mulch. One to two feet of clean-fill would also then be used as a cap for the repository material and re-vegetated in a similar manner to former waste areas.

This alternative is highly implementable and will meet Removal Action Goals with moderate effectiveness and may be completed in phases as funding sources are available. This Alternative addresses the human health and ecological exposure risk by capping contaminated wastes in an on-site repository. The repository cap provides a physical barrier to recreational visitors at the site through the clean-fill and subsequent revegetation of fill on repository and former waste areas. However, the potential siting location for this repository is directly in a mapped avalanche path so migration of contaminated material is still a possibility under certain weather conditions.

The total cost for this alternative is $788,288. This includes hauling of 810 CY of suitable cover material from Telluride, CO, as well as all necessary clearing, grading, excavation, and placement of contaminated material in constructed repository. This does not include a 30-50% contingency for further detailed design. Anticipated annual maintenance costs would be around $5,000 for the first three years to ensure sufficient establishment of native vegetation across the repository cap and former waste/tailings areas. A further breakdown of costs and quantities for this Alternative are shown in Appendix B.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES AND JUSTIFICATION OF SELECTION

This section presents a comparison of the removal action alternatives for the Site and discusses potential problems or site limitations within each option. The information developed for each alternative in terms of effectiveness, implementability and cost is presented in tabular format for the Site followed by a brief comparison discussion.

5.1 Atlas Mill Comparison of Alternatives

To begin the comparative analysis, a table of information on the effectiveness, implementability and cost for the removal action alternatives at the Atlas Mill is presented in Table 11.

Table 11. Comparison of Alternatives

Alternative	Achieves Removal Action Goal	Implementability	Effectiveness	Costs	Rank
1. No Action	No	High	Low	$5,000	5 (last)

Alternative	Achieves Removal Action Goal	Implementability	Effectiveness	Costs	Rank
2. Grade and cover exposed tailings and waste rock	Yes	Moderate	High	$681,240	2
3. In-situ phytostabilization and stream bank stabilization	Yes	Moderate-High	Moderate-High	$300,831	1
4. Off-site disposal	Yes	Low	High	$4,093,450	4
5. Repository Construction	Yes	Moderate	Moderate	$788,288	3

5.2 Alternative 1: No Action

Alternative 1: No Action is highly implementable and has limited effectiveness and low costs. However, this alternative is not expected to achieve Removal Action Goals because it does not address the main concerns of the project, which pertain to mobilization of contaminated material offsite, ecological health, and minimization of hazardous material exposure. Therefore, Alternative 1 will not be considered as the preferred option and is ranked last out of the five options.

5.3 Alternative 2: Cover of exposed tailings and waste Rock

Alternative 2: Cover of exposed tailings and waste rock with geotextile fabric and clean-fill is moderately implementable and highly effective especially when combined with surface water controls. However, this Alternative has significant costs due to import of geotextile material and off-site cover material. While this Alternative would address some of the main contamination and stabilization goals of the project, it is ranked third with respect to the other Alternatives due to imported fill and geotextile costs, as well as recreational visitor interactions with hauling. The geotextile fabric also introduces a non-native material to the site that could be exposed during avalanche or over-bank flow events. This fabric could also act as a slip plane causing future exposure of underlying tailings and waste rock in steeper areas. Due to the ineffectiveness of stabilization of wastes on-site and increased costs, this Alternative was ranked second out of the five in ability to implement.

5.4 Alternative 3: In-situ phytostabilization and stream bank stabilization

Alternative 3 involves grading, amending, and revegetating exposed tailings and waste rock. This option also addresses surface water control post-treatment through installation of swales and drainage fans. Stream bank stabilization will also be implemented along two sections to reduce erosion and mobilization of material off-site. This Alternative is moderately to highly effective

with moderate costs.

While this Alternative does not fully eliminate exposure risks to tailings and waste rock like other Alternatives, it does effectively stabilize material in place while eliminating risk of off-site migration for a fraction of the costs. In the event of an avalanche or other over-bank event, the combination of in-situ phytostabilization, swale installation, and streambank work will provide sufficient stabilization and promote revegetation, as demonstrated by other similar actions on CERCLA sites throughout Colorado (Figure 5.1).

Figure 5.1: Before (left) and After (right) conditions of a USFS CERCLA site on the Rio Grande National Forest where In-situ phytostabilization was performed as the recommended alternative. The before conditions represent contaminated soil present prior to amending while the after conditions are following incorporation of limestone, fertilizer, and native seed/slash one year after treatment.

By amending the waste rock/tailings in place, the remaining mixture would be effectively treated even if mobilized by an avalanche. The treated soils would have a higher pH and sequestered metals unavailable for uptake to ecological and other communities even if exposed. In addition to this benefit, a reduction of on and off-site trucking would be created since contaminated material would be treated on-site. Amending the soil would allow for native plant establishment post-treatment, and development of successive natural soil formation. By accumulating organic matter and subsequent decomposition of other site biomass, a dark upper layer of soil (A horizon) and underlying C horizon would develop over time following treatment. This natural soil buffer zone that would replace the need for generation of on or off-site clean cap material. That depth of clean soil horizon will only increase over time as the natural plant succession proceeds, thus increasing the buffer between ecological community and reclaimed waste. Incorporation of this approach would minimize trucking and interactions with recreational visitors associated with Alternatives 2, 4, and 5.

Given the potential for stabilization success and low costs associated with this Alternative, it was ranked as the first option, and is therefore selected as the Recommended Removal Action

Alternative for the Atlas Site. A detailed description of implementation actions associated with this Alternative is further discussed in Section 7.

5.5 Alternative 4: Offsite Disposal

Alternative 4: Offsite Disposal is highly effective but the implementability is low due to remote location, risks of accidents from high road traffic volume, and high costs. The costs of this alternative are extremely high due to the off-site hauling costs to the Montrose County Landfill and costs necessary to bring in clean-fill material to replace removed waste.

The ability to implement this removal action alternative is considered low due to the long haul on narrow mountain roads with a high chance of accident/incident due to the high recreational traffic volume on the road, resulting in uncontrolled releases into pristine areas. As stated earlier in the document, up to 15,000 to 27,000/month of recreational users visit this area during the summer and fall months, which would correspond to the only window available for construction at the Site. The number of truck-loads necessary to haul offsite would pose significant risk to recreational users around the Site. Because of the high altitude and long winter season at the Site, interactions between hauling operations and recreational users would be unavoidable. Also, in association with the hauling, road maintenance would be necessary due to the repetitive moving of material on and off site. Flagging crews would also be needed during the entire construction window to ensure safety of recreational visitors using the road. Due to the sheer volume of trucking and high costs necessary to complete this Alternative, it is ranked fourth out of the five options.

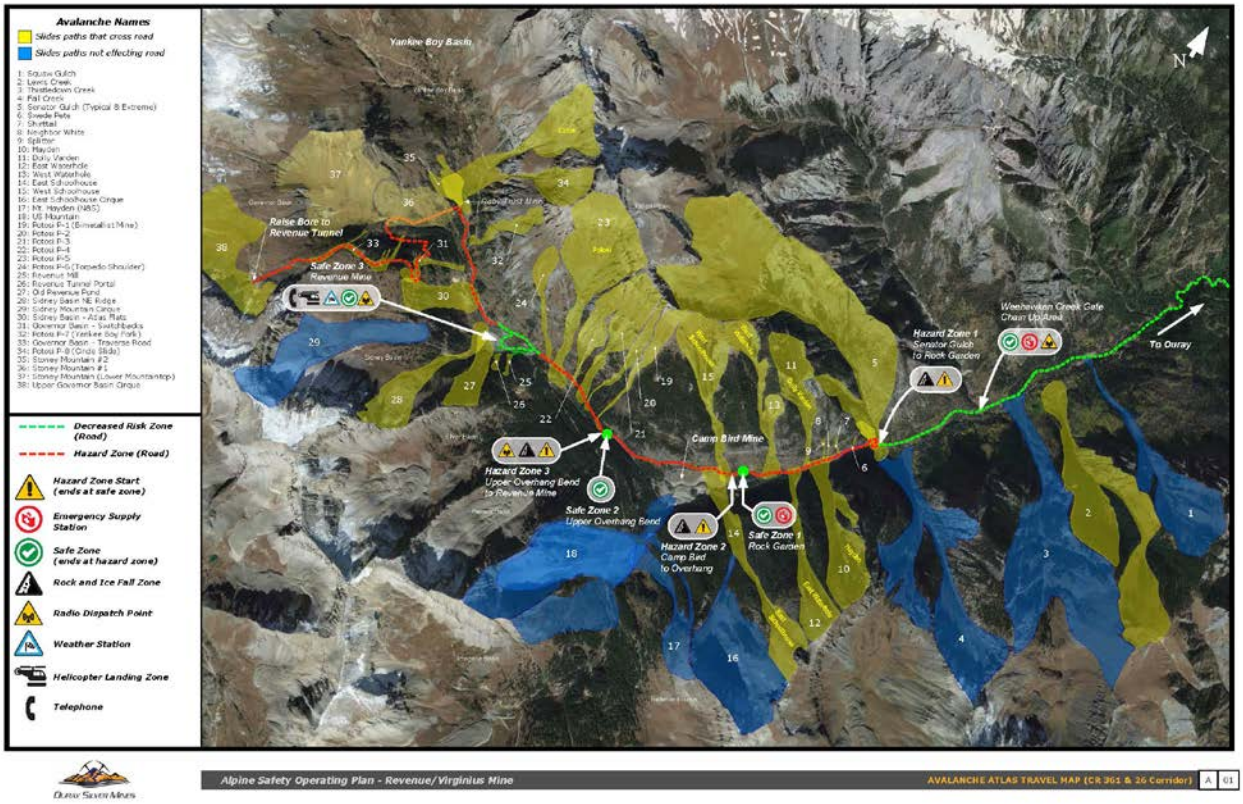
5.6 Alternative 5: Repository Construction

Alternative 5: Repository construction is a highly effective solution to the problems that exist at the Atlas Site, especially with regards to minimization of ecological and human health exposure pathways, in the short-term. However, implementation and long-term efficacy challenges associated with this Alternative make justification of its selection difficult per the Removal Action Goals.

One implementation challenge is cost. At $788,288, it is over $100,000 more than Alternative 2 due to the construction of the repository and extra clean-fill necessary to cap repository materials and excavated areas. Another complicating factor with implementation is the mixed ownership of the Site. Since tailings and wastes both fall on USFS and OSMI property, a repository agreement would have to be generated and agreed upon by both parties. This would enable placement of private wastes on National Forest system lands. Developing this agreement would likely entail a longer timeline for implementation due to additional soil sampling and further quantification of private wastes through test pits or geotechnical investigations.

While a repository more effectively limits certain exposure pathways than some other options, a

repository is unlikely to withstand the repetitive avalanche cycles, which reduces the long-term stability and efficacy of the solution. There are 38 named-slide paths in the greater basin surrounding the Site area (Figure 5.2), as mapped by Telluride Helitrax in support of OSMI



operations. The particular slide path that would most affect Site actions is number 30, or the Sidney Basin – Atlas Flats path (Figure 5.2).

Figure 5.2: Alpine safety operating plan for the Revenue/Virginius Mine courtesty of OSMI. This map shows all the avalanche slide paths in the associated basins.

The risk associated with the Sidney Basin – Atlas Flats slide path is considered a high avalanche hazard with moderate to extreme conditions (Figure 5.3). Focusing on the area near the Site and the Revenue/Virginius mine, a red high hazard polygon is highlighted at the run-out of the Atlas Flats slide path (8 in the Figure 5.3).

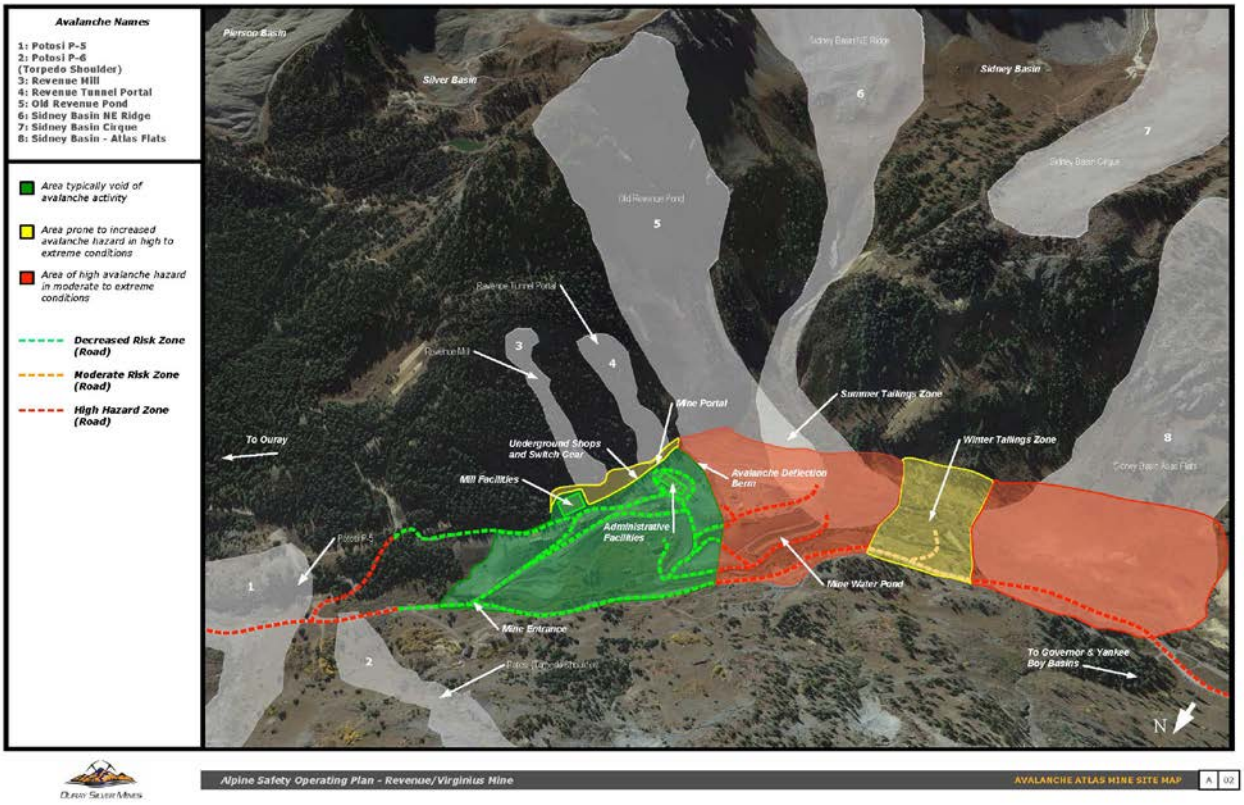


Figure 5.3: Alpine safety operating plan for Revenue/Virginius Mine in the vicinity of the Atlas Mine/Mill project location. The grey tailings zone and edge of the yellow tailings can be seen in the right corner of the Figure in the Sidney Basin Atlas Flats slide path.

The grey tailings area where the proposed repository would be located falls within this area. An avalanche of high hazard could easily rip out a repository and expose untreated tailings and waste rock to the environmental or recreational community. In the event of an avalanche, there is also the risk of mobilizing repository contents into Sneffels Creek and further off-site, thus rendering that treatment option ineffective with regards to stabilization, and no more preferable than Alternative 3. These slide paths are delineated because they occur with high frequency, especially the one present above the Atlas Site. During a site visit in May of 2019, staff observed a recent avalanche in this exact slide path, as well as many others within the drainage (Figure 5.4).

Figure 5.4: Actual post-avalanche slide conditions on way up to Site area in May 2019. High hazard zones like the one above the Site at Atlas are prone to slide each year, and could have a detrimental affect on removal actions.

Due to a combination of these adverse implementation and long-term efficacy factors, Alternative 5 was ranked third out of the five options and will not be considered as the primary Alternative.

6.0 DATA GAPS

Data gaps are identified below, in particular those gaps that need to be filled to address environmental review requirements. As part of the progress from the current Conceptual Design (30%) to a Detailed Design (90%), the following data gaps should be addressed:

Alternative 1 - No Action/No Data Gaps

Alternative 2 – Cover Exposed Tailings and Waste Rock Areas

A. Identify specific source of tailings cover.
B. Conduct geotechnical stability testing of waste rock pile.
C. Specify storm event to size run-on and -off controls, and sedimentation ponds.

Alternative 3 - Stream Bank Stabilization, Waste Rock Controls, Consolidate and Stabilize in Place, Neutralize Exposed Tailings and Establish Vegetation

A. Q2, Q25, and Q100 flow event modeling for tailings floodplain removal
B. Specify storm event to size run-on and run-off controls and delineate what materials need to be removed from floodplain.
C. Specify amendment rates based on test plots installed last Fall 2018.

Alternative 4 - Offsite Disposal of Both Yellow and Grey Tailings

A. Identify specific disposal facility within reasonable distance of Site.
B. Evaluate traffic risk and potential encounters with recreational users/visitors.

Alternative 5 – Repository Construction

A. Quantify truck -loads of off-site clean fill that would be necessary to complete SOW
B. Evaluate traffic risk and potential encounters with recreational users/visitors
C. Look into avalanche risks associated with specified and known slide paths.

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the information gathered to date and based on the evaluation of alternatives, the recommended alternative for the Atlas Mine/Mill Site is Alternative 3, which includes in-situ phytostabilization of tailings/waste rock, grading and revegetation, waste rock surface water controls, and stream bank stabilization. Further justification for this Alternative comes from other similar projects completed on Federal Lands in the West (BLM, 2006 and USFS, 2003). Past USFS studies have shown that acidic mine spoils can be treated successfully in place with lime, organic matter, fertilizer, and seed with native grasses followed by mulching (USFS, 2003). The native plant establishment of this proposed process allows for natural formation of actual soil over time from the accumulation of organic matter and decomposition of other site biomass. These past approaches, which align with the proposed Alternative, effectively restore disturbed lands to a self-sustaining, diverse, and resilient state that is necessary in remote and harsh conditions similar to Atlas.

This alternative was chosen because it best achieves the Removal Action Goals. Specifically, it can be effectively implemented with low site disturbance and minimal interaction with recreational users, and the long-term operation and maintenance will be minimal. The costs are moderate when compared to other Removal Action Goals, and the proposed scope of work fits within the current budget and funding sources from USFS, the State of Colorado SEP Program, OSMI, and TU. This Alternative meets the main goal of the Removal Action Goals, which is stabilization of contaminated material while also reducing likelihood of mobilization of material off-site. In addition, this alternative was presented to the public during a meeting in Ouray on July 11, 2018 and received general acceptance as the preferred alternative. Figure 7.1 shows the general conceptual design for the recommended alternative.

The first step of Alternative 3 will consist of removing and consolidating any tailings or waste out of what is deemed the accessible floodplain. Removed material will be replaced with locally sourced clean-fill to maintain previous topography. Consolidated tailings and waste will be stabilized by incorporating various rates of amendments such as lime, limestone, organic compost and biochar at depths of 1.5 to 2 feet to neutralize the tailings/waste rock. Other local sources of mulch will be utilized where applicable from avalanche debris slides, as well as local options for amendment alternatives. Following incorporation, amended material will be rough graded to 3:1 slopes and then hummocked using an excavator bucket. This roughening process is an important process to dissipate sheet flow and overbank flood flow velocities once vegetation has had time to establish. Following the hummocking process, a 60/40 combination of woodstraw and agricultural straw will be applied over a riparian and upland native seed mix. Taking place concurrently with amendment incorporation will be the construction of run on/runoff controls (swales) that will be applicably installed to promote

positive drainage on and off the Site footprint. Following completion of these actions, live transplants of willows and other native species will be planted across the site to reduce erosion and provide stability during periods of runoff. Streambank stabilization and in-stream structures will also be placed at two important junctions to keep bank-full flows in the main channel, while providing stability during overbank events. Sedge and willow transplants will be placed between structures and along banks to improve condition of degraded banks. Following completion of reclamation actions on site, institutional controls and historic interpretative signage will be installed to guide and keep visitors off reclaimed surfaces. This will allow time for vegetation to establish while also minimizing interaction of visitors and reclaimed surfaces.

All of the aforementioned BMPs have the goals and objectives that align with the Removal Action Goals listed in Section 3.1. Alternative 3 will stabilize contaminated material in-place while reducing contamination and exposure to ecological receptor groups. Reclaimed portions of the site will help reduce the amount of material that will migrate off-site during overbank and flood events. Further detail on structure location and amendment rates for revegetation will be developed during the subsequent detailed design phase prior to construction.

This Alternative meets all the proposed Removal Action Goals mentioned earlier in this document while sufficiently addressing risks to ecological health and surface waters at the Site especially during times of fluctuating flow regimes. To quantify the potential flow at the Site, partners contracted with Stillwater Sciences to develop hydrologic parameters in the upper Sneffels Creek drainage. Study findings were important factors in the selection of Alternative 3 as the Removal Action Alternative. A drainage area of 4.89 acres feeds the upper reaches of Sneffels Creek above the Site, which has shown to supply flood flows between 82 cubic feet per second (CFS) and 454 CFS for two year and 100 year events, respectively (Appendix C). The aforementioned stream stabilization structures will help deflect flood flows away from reclaimed surfaces, while also acting as a series of terraces that can hold and dissipate various levels of flow. The addition swales and drainage fans will also help manage surface flows during peak flow and rainfall events. These features would help keep any material on-site and reduce any potential loading downstream by attenuating runoff and creating deposition areas. Combination of these types of BMPs will create a versatile system that can withstand certain thresholds of flood flows. However, a potential 500-year flood flow of 676 CFS would be catastrophic not only to the Site, but the entire drainage (Stillwater Sciences, 2019). No amount of engineering, BMPs, or hauling of material off-site would mitigate or off-set the damage a flood of that magnitude would have on the basin. Therefore, this Removal Action Alternative was ranked as the best-value alternative that addresses all Site concerns within a reasonable set of conditions. Performing work associated with this Removal Action will improve Site conditions while also mitigating migration of material off-site through revegetation and in-stream restoration. The potential results and benefits of Alternative 3 actions far outweigh the option of a no-action alternative and other un-feasible high-priced Alternatives.

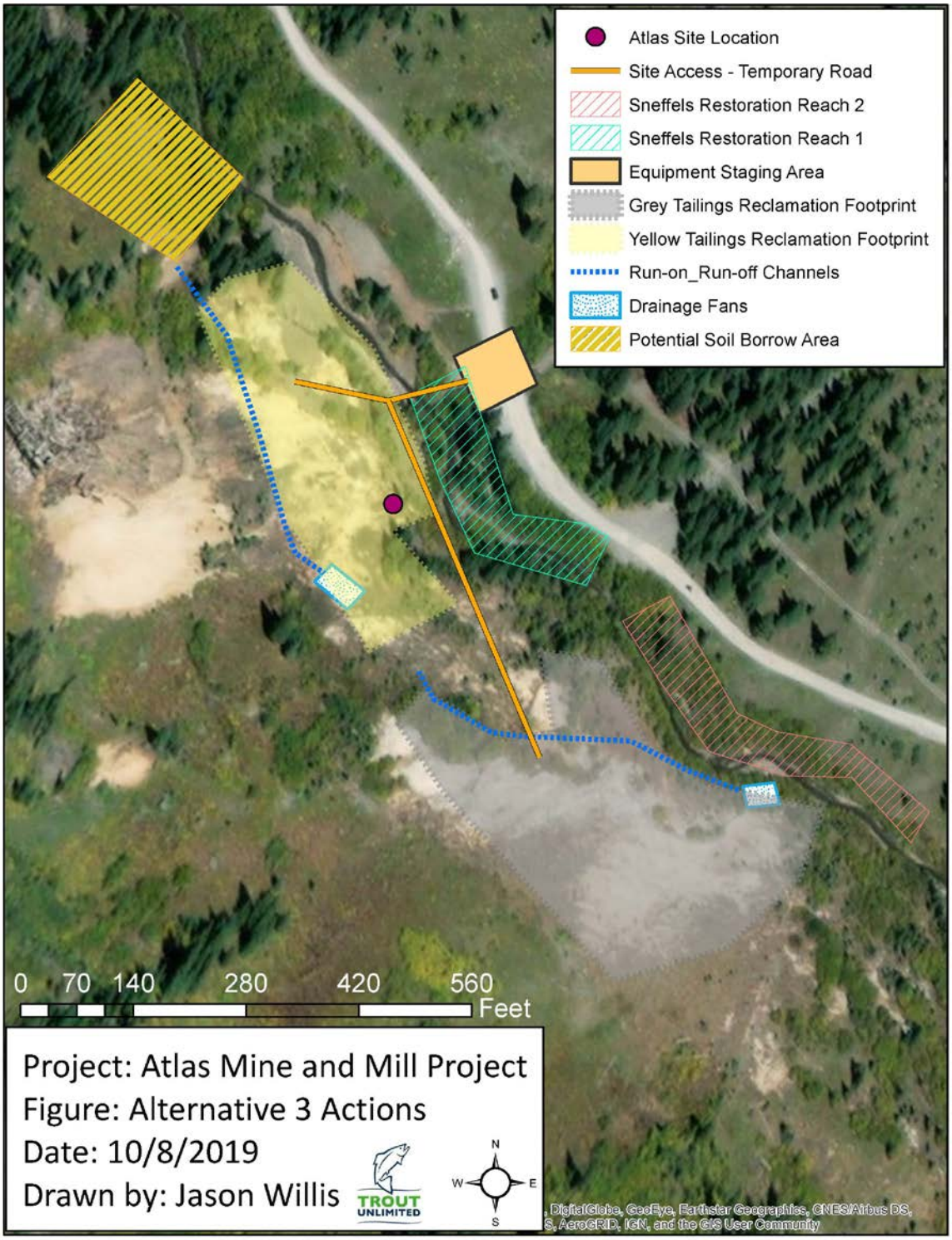


Figure 7.1: Recommended removal action alternative 3 and associated construction phases. Map shows construction staging areas and routes of access, as well as potential borrow source if needed for clean-fill generation. Estimated footprints of yellow and grey tailings areas are 4 acres. Swale locations and drainage fans are approximate and depend on final grading established in the field.

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APPENDIX A

ARARs

*Status:
Appl = Applicable
PA = Potentially Applicable; w/clarification in comments column
NA = Not Applicable
R = Relevant
Appr = Appropriate
TBC = To Be Considered

Applicable or Relevant and Appropriate Requirements

	Standard and Regulatory Citation	Status	Description	Comment	Chemical	Location	Action
			FEDERAL				
1	Federal Water Quality Criteria 40 CFR 131	Potentially Applicable	Sets standards for surface water to protect aquatic organisms and human health.	The primary Removal action goal is to stabilize contaminated material on-site, while reducing ability of that material to migrate or be mobilized off-site. Therefore, improvement of water quality in Sneffels Creek would be a secondary benefit of the project.			
2	Clean Water Act 33 USC 1251-1387 Chapter 26	Potentially Applicable	Objective is to restore and maintain the quality of surface waters by restricting discharges of all designated pollutants, which include 126 "priority toxic pollutants" various "conventional pollutants" and certain "non-conventional pollutants".	The primary Removal action goal is to stabilize contaminated material on-site, while reducing ability of that material to migrate or be mobilized off-site. Therefore, improvement of water quality in Sneffels Creek would be a secondary benefit of the project.			
3	Endangered Species Act 316 USC § 1531 (h) through 1543 40 CFR Part 6.302 50 CFR Part 402	Potentially Applicable	Act to protect habitat of endangered and threatened species. Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat.	Site activities are expected to have minimal impact of wildlife in site footprint and adjacent areas. Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species. Procedural and enforcement provisions may not apply onsite at an USFS CERCLA removal action.			
4	Fish and Wildlife Coordination Act 16 USC 1251 661 et seq.; 40 CFR 6.302(g)	Applicable	Requires consultation when Federal agency proposes or authorizes any modification of any stream or other water body to assure adequate protection of fish and wildlife resources.	Wildlife and fisheries in Sneffels Creek will be enhanced by this work			
5	Historic Sites, Buildings, and Antiques Act and Executive Order 11593 16 USC 461 et seq.; 40 CFR Part 6.301	Applicable	EPA is subject to the requirements of the Historic Sites Act of 1935, 16 U.S.C. 461 et seq., the National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq., the Archaeological and Historic Preservation Act of 1974, 16 U.S.C. 469 et seq., and Executive Order 11593, entitled Protection and Enhancement of the Cultural Environment.	Substantive compliance with NHPA requirements satisfies this requirement. A historical investigation of the Site and surrounding area has a finding of no significant impact regarding planned removal actions. This investigation covered both private and FS lands. Procedural and enforcement provisions do not apply on-site at a USFS CERCLA removal action.			
6	Migratory Bird Treaty Act 16 USC §§ 703 et seq.	Potentially Applicable	Establishes federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the US Fish and Wildlife Service during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Bird migrations are typical of the region.			
7	National Environmental Policy Act 7 CFR 799 (1969) http://www.epa.gov/region9/nepa/	Potentially Applicable	Section (102)(2) of NEPA requires all Federal agencies to give appropriate consideration to the environmental effects of their proposed actions. The Council on Environmental Quality regulations at 40 CFR 1507.3(b) identify those items which must be addressed in agency procedures.	Wildlife, fisheries, cultural resources will be considered through the CERCLA process and not under NEPA. This is process will be covered as outlined under the doctrine of functional equivalence.			

Applicable or Relevant and Appropriate Requirements

Standard and Regulatory Citation		Status	Description	Comment	Chemical	Location	Action
8	Protection of Wetlands Order, Executive Order 11990 40 CFR Part 6	Applicable	Requires minimizing and avoiding adverse impacts to wetlands.	A wetland delineation was completed, and wetland areas will be maintained at the site.			
9	Floodplain Management, Executive Order 1198842 USC 4321 et seq.; 42 USC 4001 et seq.	Potentially Applicable	Requires evaluating the potential effects of actions that may take place in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain.	Some remediation activities may be in floodplain, but these actions will not alter the configuration of the floodplain.			
10	Archaeological Resources Protection Act (ARPA) 16 USC Section 470 et. Seq. 40 CFR Part 7	Potentially Applicable	ARPA and implementing regulations prohibit the unauthorized disturbance of archaeological resources on public and Indian Lands. Archaeological resources are any material remains of past human life and activities which are of archaeological interest. Removal of archaeological resources from public or Indian lands is prohibited and any archaeological investigations at a site must be performed by a professional archaeologist. ARPA and implementing regulations are applicable for the conduct of any elected response action that may result in ground disturbance.	Substantive compliance with NHPA requirements satisfies this requirement. A historical investigation of the Site and surrounding area has a finding of no significant impact regarding planned removal actions. This investigation covered both private and FS lands. Procedural and enforcement provisions do not apply on-site at a USFS CERCLA removal action.			
11	National Historic Preservation Act (NHPA) 16 USC Section 470f 36 CFR Parts 60, 63, and 800 40 CFR Section 6.301	Applicable	Section 106 of NHPA process balances needs of federal undertaking with effects the undertaking may have on historic properties.	Substantive compliance with NHPA requirements satisfies this requirement. A historical investigation of the Site and surrounding area has a finding of no significant impact regarding planned removal actions. This investigation covered both private and FS lands.			
12	Bevill Amendment RCRA Section 3001 (a)(3)(A)(ii) 42 USC 6921 (a)(3)(A)(ii) 40 CFR Section 261.4(b)(7)	To be considered	Exempts most mining wastes from regulation as hazardous waste. Exempted waste includes waste from the extraction and beneficiation of minerals, and some mineral processing waste.	Further, onsite consolidation of Bevill-exempt section 3001(b)(3)(A), mining-related rock and tailings onsite at a CERCLA removal action does not constitute generation nor placement of solid wastes and is not creating a regulated landfill. Note: The Atlas Mine and Mill removal action is to be designed and constructed as not a hazardous waste facility but a naturally functioning landscape with a native vegetated cover. Further, USFS may implement any/all of the following actions to provide long-term sustainable CERCLA remedies: + Amend the Forest's Land Status Atlas to reflect the location of any engineered feature that should remain undisturbed, + Amend the Forest Service's Geographic Information System (GIS), Combined Data System (CDS), Land Status Record System (LSRS) [and/or any other mapping systems that function as the official record of National Forest System land] to note the location of the feature, + Perform periodic inspections of the engineered feature, in order to photograph and document whether it is performing as desired, + Make an administrative amendment to the Forest Plan to note the location of the feature, and to implement any restrictions that are allowed by law, such as restrictions on buildings, water supply wells or utility lines, + Make an administrative amendment to the Forest Plan to note that any sale or transfer of the Site or the feature would have to meet the requirements of CERCLA 42 USC 9620(h).			
13	Federal Land Policy and Management Act of 1976 43 USC 1701 et seq.	Applicable	Governs the way in which the public lands administered by the USFS are managed.	USFS staff are involved in the project.			
14	Federal Watershed Restoration and Enhancement Agreement (Wyden Amendment) 16 USC 1011	Appropriate	Allows the Secretary of the Interior for the purpose of entering into cooperative agreements with the heads of other Federal agencies, Tribal, State, and local governments, private and nonprofit entities, and landowners for the protection, restoration, and enhancement of fish and wildlife habitat and other resources on public or private land and the reduction of risk from natural disaster where public safety is threatened that benefit these resources on public lands within the watershed.	Project is a public/private partnership and could ultimately be governed by one lead agency.			

15	Clean Air Act National Primary and Secondary Ambient Air Quality Standards National Emission Standards for Hazardous Air Pollutants 42 USC 7409 40 CFR Part 50 40 CFR Part 61, Subparts N, O, P, pursuant to 42 USC 7412	Relevant and Appropriate pertaining to disturbance of waste material during consolidation, removal, or treatment.	Establish air quality levels that protect public health, sets standards for air emissions. Regulates emissions of hazardous chemicals to the atmosphere.	Project will cause minimal and temporary disturbance during construction.			

Applicable or Relevant and Appropriate Requirements

Standard and Regulatory Citation		Status	Description	Comment	Chemical	Location	Action
16	Floodplain Management Executive Order No. 11988	To be considered	Requires Federal agencies to consider alternatives to avoid, to the extent possible, adverse effects and incompatible development in the floodplain.	Project intends to improve flood management in the mine area.			
17	Protection of Wetlands Executive Order No. 11990.	To be considered	Requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	Wetlands disturbance not anticipated.			
18	National Forest Management Act of 1976". (16 U.S.C. 1600)	Applicable	Written as the primary statute governing the administration of national forests and was an amendment to the Forest and Rangeland Renewable Resources Planning Act of 1974, which called for the management of renewable resources on national forest lands.	Some of the work will be performed on National Forest Service lands.			
19	Grand Mesa, Uncompahgre, Gunnison National Forest Proposed Land Management Plan (March 2007)	Applicable to USFS Lands	Addresses a number of national forest-specific requirements for USFS lands within GMUG, including recreation, species diversity, scenery, etc.	Work performed on National Forest Service Lands will take into consideration the GMUG Land Management Plan			
20	Best Management Practices for Soils Treatment Technologies EPA OSWER, 1997	To be considered	Provides technologies for controlling cross-media transfer of contaminants during materials handling activities.	Special conditions for the management of waste rock and mill tailings material are not anticipated.			
21	Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites	To be considered	Suggests levels for lead in soil. This factor would be considered if lead is found in elevated levels in soils remaining after contaminant removal.	The site is not a Superfund Site. Elevated concentrations of lead may exist in tailings materials left on site.			
STATE/LOCAL							
22	Colorado Basic Standards & Methodologies for Surface Water, 5 CCR 1002-31, pursuant to C.R.S. § 25-8-101 *et seq.*	Potentially Applicable	This regulation establishes statewide surface water quality standards for acceptable concentrations of specified parameters including chemical constituents and pH. The regulation also establishes methodologies for assigning and implementing those standards. Reg 31 non-degradation standard.	Sneffels Creek flows through the site and is on the State 303(d) list for cadmium, lead, and zinc impairment of aquatic life use standards (COGUUN005). However, the removal action goal for site is NOT to clean up Sneffels Creek, but to mitigate the migration of contaminated material and surface tailings/waste rock off-site. The removal action will accomplish this goal through in-situ phytostabilization, grading and revegetation, surface control installation, and stream bank stabilization. During work, existing water quality in Sneffels Creek will not be impacted and could potentially be improved as a secondary effect of reclamation.			
23	Colorado Discharge Permit System (CDPS) Regulations, 5 CCR 1002-61.3(2)(a) and (f)(ii), and CDPS general permit No. COR0300000 (Stormwater discharges associated with construction activity), pursuant to CRS § 25-8-501	Potentially Applicable	Requires implementing management controls through defined “general limitations” and “best management practices” for stormwater pollution prevention pursuant to Colorado Discharge Permit System general permit COR03000002. This permit applies to stormwater discharges from small construction activities, including clearing, grading, and excavating, that result in land disturbance of equal to or greater than one acre and less than five acres.	Substantive requirement(s) of regulation apply for any release of stormwater off-site. Design will include BMPs that meet substantive requirements of ARAR. These BMPs will include installation of run-on/run-off controls adjacent to revegetated areas and Silt Fences to control surface runoff during construction. Procedural and/or enforcement provisions not applicable onsite at an USFS CERCLA removal action. There are no point source discharges currently at the site and no draining adits.			

24	Mined Land Reclamation Board Regulations for Hard Rock, Metal, and Designated Mining Operations,: Reclamation Performance Standards, 2 CCR 407-1 Rules 3.1.5(10) and (11), pursuant to the Colorado Mined Land Reclamation Act, CRS § 34-32-101 *et seq.*	Potentially Applicable	Acid forming or toxic producing mined materials must be handled and disposed in a manner that will protect the surface and groundwater drainage system from pollution. This ARAR also regulates all aspects of mining, including location of operations, reclamation, and other environmental and socioeconomic impacts.	Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Further, there is no generation and/or placement of any wastes from off-site sources within the footprint of existing CERCLA site boundary. The RA is taking place next to an adjacent site with an active mining permit, but will have no interaction with that mine/permit.			
25	Mined Land Reclamation Board Regulations for Hard Rock, Metal, and Designated Mining Operations,: Reclamation Performance Standards, 2 CCR 407-1 Rule 3.1.8, pursuant to the Colorado Mined Land Reclamation Act, CRS § 34-32-101 *et seq.*	Potentially Applicable	Reclamation activities must take into account the safety and protection of wildlife on the mined site and along access roads with special attention given to critical periods in the life cycle of species requiring special consideration (elk calving, migration routes, peregrine falcon nesting,grouse strutting grounds).	Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species. Substantively covered by Federal Endangered Species Act			
26	Colorado Fugitive Dust Control Plan/Opacity, Regulation No. 1., 5 CCR 1001-3, pursuant to Colorado Air Pollution Prevention and Control Act, CRS § 25-7-101 *et seq.*	Relevant and Appropriate	Requires control measures to manage fugitive emissions from construction activities, storage and stockpiling activities, haul trucks and tailings ponds.	Substantive requirements of dust control/opacity will be included during implementation of RA due to placement, grading, amending, and subsequent revegetation activities onsite. Compliance with worker safety requirements onsite will preclude any offsite air release(s). Procedural and enforcement provisions do not apply onsite at an USFS CERCLA removal action.			
27	Colorado Mined Land Reclamation Board Regulations ("MLRB Regulations"), Reclamation Performance Standards, 2 C.C.R. 407-1, Rule 1.1 (definitions) and Rule 3 (Reclamation Performance Standards), pursuant to the Co. Mined Land Reclamation Act, C.R.S. § 34-32-101 *et seq.*	Relevant and Appropriate	The MLRB Regulations require reclamation of permitted mined lands, defined as "employment of procedures reasonably designed to minimize as much as practicable the disruption from mining operations and to provide for the establishment of plant cover, stabilization of soil, the protection of water resources, or other measures appropriate to the subsequent beneficial use of such affected lands." Reclamation must be conducted in accordance with the performance standards in Rule 3 of the Regulations.	Substantive reclamation requirements may be relevant and appropriate at the Atlas Mine and Mill site due to the in-situ phytostabilization and revegetation of mine wastes/tailings on-site. Procedural and/or enforcement aspects of MLRB Regulations are not applicable onsite at an USFS CERCLA removal action.			
28	MLRB Regulations Rule 3.1.5(1), (3), and (7)	Applicable	Any grading shall be done in a manner to control erosion and siltation and protect from slides and other damage. High walls shall be stabilized or eliminated. Grading shall create a final topography appropriate to the future land use. Slopes and slope combinations shall be compatible with the configuration of surrounding conditions and future land use.	Substantive requirements are applicable onsite due to the regrading and consolidation of mine waste/tailings. However, procedural and/or enforcement aspects of MLRB Regulations are not applicable onsite at an USFS CERCLA removal action. Note: there are no lakes or ponds at this site.			
29	MLRB Regulations Rule 3.1.5(2)	Potentially Applicable	Backfilling shall ensure adequate compaction for stability and prevent leaching of toxic or acid forming materials.	Any consolidation and compaction of mine wastes/tailings could potentially apply. However, the grading plan will ensure adequate compaction combined with minimizing the mobilization of material offsite which is the main removal action goal. Groundwater is outside of the scope of this USFS CERCLA removal action and affects from leaching are not considered.			
30	MLRB Regulations Rule 3.1.8	Potentially Applicable	Reclamation activities must take into account the safety and protection of wildlife on the mined site and along access roads with special attention given to critical periods in the life cycle of species requiring special consideration (elk calving, migration routes, peregrine falcon nesting, grouse strutting grounds).	Substantively covered by Federal Endangered Species Act Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species.			
31	Colorado Noxious Weed Act and Ouray County Noxious Weed regulations, CRS § 35-5.5-101-119; 8 CCR 1206-2	Applicable	Colorado regulations addressing management of noxious weeds.	Revegetation activities will include use of certified weed-free native seed mix, as well as weed-free sources of straw and wood straw products used in reclamation.			

32	Colorado Wildlife Enforcement and Penalties Act, CRS §§ 33-6-101 to 130.	Potentially Applicable	Prohibits actions detrimental to wildlife, and establishes provisions governing the taking, possession, hunting and use of wildlife and migratory birds.	Site activities are expected to have minimal impact of wildlife in site footprint and adjacent areas. Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species. Procedural and enforcement provisions may not apply onsite at an USFS CERCLA removal action.			
33	Colorado Non-game, Endangered, or Threatened Species Act, CRS §§ 33-2-101-108	Potentially Applicable	Protects endangered and threatened species and preserves their habitats. Requires coordination with the Colorado Parks and Wildlife if removal activities impact nongame wildlife deemed to be in need of management.	Site activities are not expected to have a long-term impact to threatened species. T&E species habitat should be improved through removal action goal implementation. Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species. Procedural and enforcement provisions may not apply onsite at an USFS CERCLA removal action.			
34	Colorado Wildlife Commission Regulations, 2 CCR 406, pursuant to CRS §§ 33-2-101-108	Potentially Applicable	Establishes specific requirements for protection of wildlife.	Substantively covered by Federal Endangered Species Act Generally, removal action design will meet substantive requirements of these standards, however, procedural and/or enforcement aspects of these standards are not applicable onsite at an USFS CERCLA removal action. Removal action will comply with substantive requirements of Endangered Species Act and consider any state-specific species. Procedural and enforcement provisions may not apply onsite at an USFS CERCLA removal action.			
35	Colorado Historic Preservation Regulations, 8 CCR 1504-7, pursuant to CRS 24-80-401 to 410, and 1301 to 1305.	Applicable	Establishes requirements for protecting properties of historical significance; establishes procedures and requires a permit for investigation, excavation, gathering, or removal from the State of any historical, prehistorical, or archeological resources on State Lands. Requires an excavation permit and notification if human remains are found on State Lands. Note: The National Historic Preservation Act is more stringent.	Substantive compliance with NHPA requirements satisfies this requirement. A historical investigation of the Site and surrounding area has a finding of no significant impact regarding planned removal actions. This investigation covered both private and FS lands. Procedural and enforcement provisions do not apply on-site at a USFS CERCLA removal action.			
36	Colorado Primary and Secondary Ambient Air, 5 CCR 1001-14, pursuant to CRS 25-7-108	Potentially Applicable	Sets ambient air quality standards for a variety of constituents, including particulate matter and lead.	Appropriate BMPs will be utilized during RA activities at the site to minimize any generation of dust or other particulate matter.			

APPENDIX B

Removal Alternatives Cost Estimates

Alternatives Cost Estimates
Atlas Mill Area

#	Item	Quantity	Units	Unit Price	Cost	Notes
1	**Alternative 1: No Action/No Cost**					
1.1	Signage	1	LS	$ 5,000	$ 5,000	Estimated costs for placing signage around the tailings area and along the site side of the creek. placement at approximately 200 feet intervals.
	subtotal				**$ 5,000**	
2	**Alternative 2: Cover Exposed Tailings and Waste Rock Areas**					
2.1	Mobilization/Demobilization and Erosion Control & Permitting	1	LS	$ 35,000	$ 35,000	Equipment Mobilizationand Demobilization, Erosion Control Installation, Obtaining Permits and Creating Access
2.2	Grading of Yellow and Grey Exposed Tailings	3.6	AC	$ 10,000	$ 36,000	Grading of exposed tailings
2.3	Exposed Tailings: Cover Materials, Seeding, and Amendments Placement	3.6	AC	$ 53,000	$ 190,800	Assumes import of soil for 1.0 ft cover, spreading, seeding and mulch
2.4	Waste Rock-Geotechnical Cover	0.6	AC	$ 653,400	$ 392,040	Reinforced soil slope
2.5	Waste Rock-Runon Controls	300	LF	$ 25	$ 7,500	Excavation, erosion control fabric, riprap, filter fabric, boulder drops
2.6	Waste Rock-Runoff Controls	350	LF	$ 25	$ 8,750	Excavation, erosion control fabric, riprap, filter fabric, boulder drops
2.7	WasteRock-Runoff Sedimentation Pond	7200	CF	$ 1	$ 5,400	Typical stormwater detention pond (EPA) 30 x 30 x 8 ft
2.80	Roadside Ditch to Waste Rock-Captures Mill and Springs Runoff	150	LF	$ 5	$ 750	Road grader
2.9	Signage	1	LS	$ 5,000	$ 5,000	Estimated costs for placing signage around the tailings area and along the site side of the creek. placement at approximately 200 feet intervals.
	Subtotal				**$ 681,240**	
					$ 476,868	Subtotal (-30%) Conceptual Cost Low Range
					$ 1,021,860	Subtotal (+50%) Conceptual Cost High Range
3	**Alternative 3: Stream Bank Stabilization, Waste Rock Controls, Neutralize Exposed Tailings and Establish Vegetation**					
3.1	Mobilization/Demobilization and Erosion Control & Permitting	1	LS	$ 35,000	$ 35,000	Equipment Mobilizationand Demobilization, Erosion Control Installation, Obtaining Permits and Creating Access
3.2	Stream Bank Stabilization					

Alternatives Cost Estimates
Atlas Mill Area

3.2.1	Excavation and Consolidation of tailings adjacent to Sneffels Creek	444	LCY	$ 14	$ 6,222	Excavated material will be moved away from Sneffels Creek and placed to promote drainage. Reach 1: No evidence of historical tailings on banks. Reach 2: Approx 200 LF of tailings avg 3 ft depth on south bank to be excavated 20 feet from stream
3.2.2	Drainage Fan at Mouth of Intermittent Drainage before entering Sneffels Creek	3,200	CF	$ 0.8	$ 2,400	Typical Drainage Fan
3.2.3	Stream Bank Stabilization-Reach 1	150	LF	$ 174	$ 26,156	Excavate sediment, transport on-site rip rap boulders, plant willows and riparian shrubs
3.2.4	Stream Bank Stabilization-Reach 2	300	LF	$ 174	$ 52,311	Excavate sediment, transport on-site rip rap boulders, plant willows and riparian shrubs
3.3	Redirect Run-on and -off in Waste Rock Area and Entrance Road					
3.3.1	Waste Rock-Runon Controls	300	LF	$ 25	$ 7,500	Excavation, erosion control fabric, riprap, filter fabric, boulder drops
3.3.2	Waste Rock-Runoff Controls	350	LF	$ 25	$ 8,750	Excavation, erosion control fabric, riprap, filter fabric, boulder drops
3.3.3	WasteRock-Runoff Drainage Fan	7200	CF	$ 0.8	$ 5,400	Typical drainage fan
3.3.4	Roadside Ditch to Waste Rock-Captures Mill and Springs Runoff	150	LF	$ 5	$ 750	Road grader
3.4	Exposed Tailings Treatments					
3.4.1	Grading of Yellow and Grey Exposed Tailings	3.6	AC	$ 10,000	$ 36,000	Grading of exposed tailings
3.4.2	Revegetation of Grey Tailings, including neutralization, compost, seeds, riparian species	1.9	AC	$ 28,200	$ 53,580	See tab for Burlington Mine, Tailored to Atlas Mine
3.4.2	Revegetation of Yellow Tailings, including neutralization, compost, seeds, riparian species	1.7	AC	$ 36,331	$ 61,762	See tab for Burlington Mine, Tailored to Atlas Mine
3.5	Signage	1	LS	$ 5,000	$ 5,000	Estimated costs for placing signage around the tailings area and along the site side of the creek. placement at approximately 200 feet intervals.
	Subtotal				**$ 300,831**	**Subtotal Estimated Probable Cost**
					$ 210,582	Subtotal (-30%) Conceptual Cost Low Range
					$ 451,247	Subtotal (+50%) Conceptual Cost High Range

Alternatives Cost Estimates - continued

4	Alternative 4: Offsite Disposal Both Yellow and Grey Tailings					
4.1	Mobilization/Demobilization and Erosion Control & Permitting	1	LS	$ 35,000	$ 35,000	Equipment Mobilizationand Demobilization, Erosion Control Installation, Obtaining Permits and Creating Access
4.2	Clearing	1	AC	$ 8,450	$ 8,450	
4.3	Excavation of tailings and waste rock	45000	LCY	$ 10	$ 450,000	Estimated quantity of tailings in low lying areas near Sneffels Creek, includes all of the yellow and grey tailings. Estimated quantity based on an average depth of 3 feet below existing grade.
4.4	Transport to disposal facility (Montrose landfill)	4500	LCY	$ 300	$ 1,350,000	Estimated Trucking Costs per 10 Cubic Yard load
4.5	Disposal facility fees	45000	LCY	$ 50	$ 2,250,000	Estimated quantity of tailings in low lying areas near Sneffels Creek, includes all of the yellow and grey tailings. Estimated quantity based on an average depth of 3 feet below existing grade.
4.6	Revegetation	8	AC	$ 3,500	$ 28,000	Includes 800# Fertilizer/Acre, Native Seed Variety and an Initial Cover of Wood Hay.
4.7	Signage	1	LS	$ 5,000	$ 5,000	Estimated costs for placing signage around the tailings area and along the site side of the creek. placement at approximately 200 feet intervals.
	Subtotal				**$ 4,093,450**	
Alternative 5: Repository Construction						
5.1	Mobilization/Demob and erosion control/permitting	1	LS	$37,600	**$37,600**	Control installation, Obtain permits, create and reclaim access
5.2	Clearing	1	AC	$8,000	**$8,000**	Clear and remove trees, shrubs and surficial debris from proposed repository area.
5.3	Prepare repository subgrade – Rough Grading	43,560	SF	$0.10	**$4,356**	Proofroll and fine-grade repository on sloped area
5.4	Excavation of Yellow Tailings and place at repository	14,200	CY	$12	**$170,400**	Excavate “yellow” tailings and place within designated repository areas.
5.5	Backfill and compact fill at excavation	14,200	CY	$12	**$170,400**	Place and compact fill materials where excavation was performed. Return area to existing grades where needed.
5.6	Relocate Grey Tailings (top 1ft)	85,875	SF	$0.40	**$34,732**	Relocate (by excavator or dozer) grey tailings upslope within repository area.
5.7	Import and place repository soil cover	807	CY	$420	**$338,800**	Procure, transport and place soil cover on repository
5.8	Seeding and tailings amendments within repository	1.00	AC	$24,000	**$24,000**	Amend tailings within repository and place seed/mulch on top.
	Subtotal				**$ 788,288**	

APPENDIX C

Peak Flow Hydrology Analysis for Sneffels Creek at Atlas Mill Site

Stillwater Sciences

TECHNICAL MEMORANDUM

DATE:	March 6, 2019
TO:	Geosyntec: Jim Cowart, Jeff Kurtz
FROM:	Stillwater Sciences: Johannes Beeby, Travis Stroth, Julie Ash
SUBJECT:	Peak Flow Hydrology Analysis for Sneffels Creek at Atlas Mill Site

Sneffels Creek and a small spring-fed tributary flow along and through the Atlas Mill site near Ouray, Colorado. Treatments are needed at the site to prevent flows from accessing mine tailings that are present in the Sneffels Creek floodplain. Potential concerns include scour from the creek and tributary that exposes the tailings from toe of bank, overland flow that contacts the tailings from the landward side, and inundation that could cause leaching from the tailings. Analysis and design of proposed treatments requires comprehensive understanding of the water and sediment processes shaping these creeks, which is built on best estimation of hydrologic regime.

This technical memorandum documents the hydrologic analysis conducted at the Atlas Mill site to provide estimates of peak flows for Sneffels Creek based on best information currently available and using rapid calculation methods for quick results. No analysis was conducted for the small tributary on the site. More detailed hydrologic methods, including basin scaling and HEC-HMS and similar models, could be employed in the future when more time and budget are available.

Hydrologic analysis for Sneffels Creek started with a search for available hydrology data around the project area. In general, existing hydrology data is limited for the Sneffels Creek area and estimated peak flow values given here relied heavily on the USGS StreamStats regression equations. Other data that was located are described below. These data were used to provide multiple lines of evidence to help support and or adjust peak flow values estimated within StreamStats.

StreamStats

StreamStats is an online tool developed by the USGS to help estimate an array of hydrologic parameters in ungaged basins using a series of regression equations developed for each state. The regression equations for Colorado were developed for five hydrologic regions statewide based on similar hydrology and climatology characteristics including the Plains, Mountain, Rio Grande, Southwest, and Northwest Regions (Figure 1). StreamStats uses analysis of USGS streamflow gages of varying hydrologic parameters in each region to develop the regional regression equations for natural streamflow statistics.

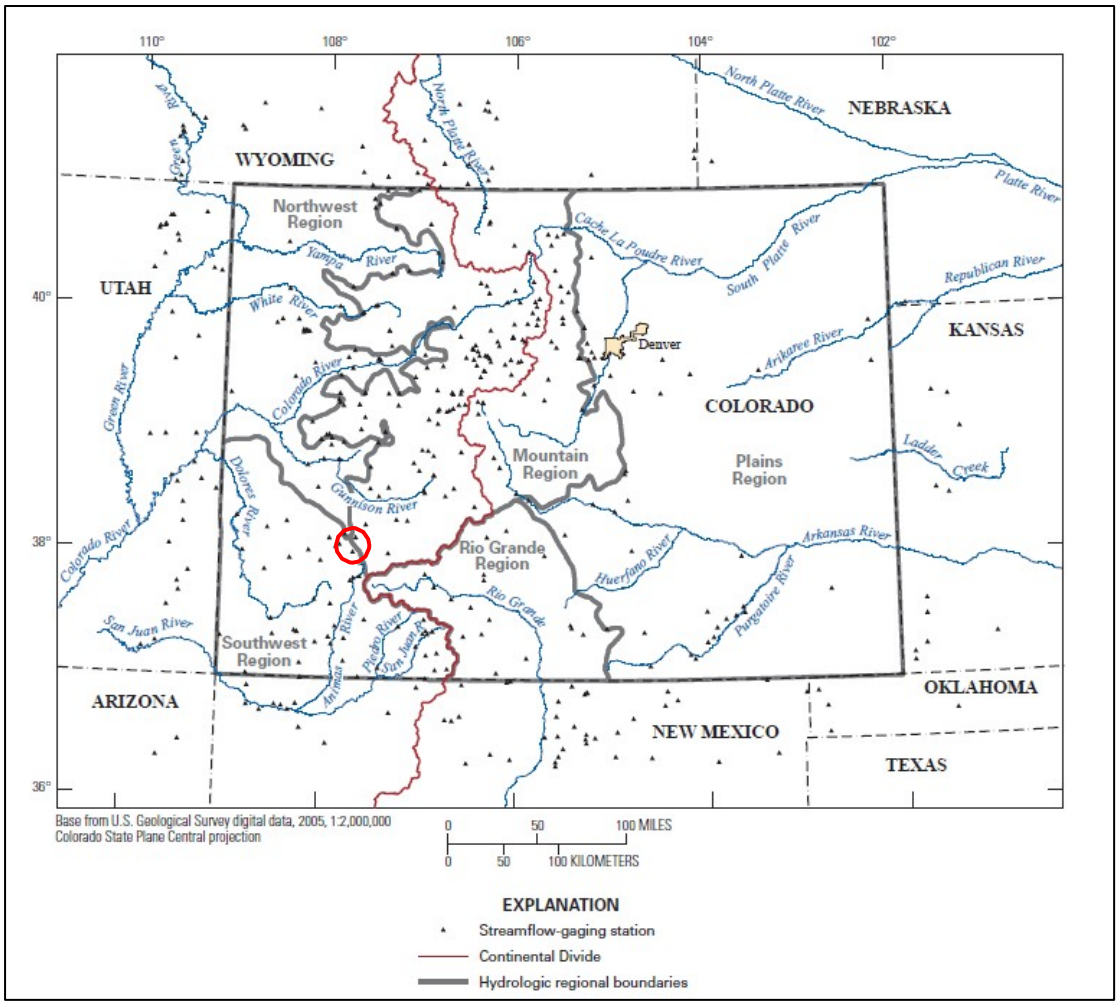

Figure 1: Five Regions with regression equations for StreamStats in Colorado. Approximate location of project site shown in red circle.

Sneffels Creek is contained within the Southwest Region as defined by StreamStats, however it also closely borders the Mountain and Northwest Regions. The red circle in Figure 1 shows the approximate location of Sneffels Creek at the Atlas Mill site. This analysis utilized default outputs from StreamStats used the Southwest Region regression equations, and additionally manually calculated equation for the Mountain and Northwest Regions due to the proximity of the basin to the other Regions and to provide comparison to inform level of confidence in results.

The parameters considered in the regional regression equations are summarized in Table 1. The Southwest Region uses drainage area and percent drainage area above 7500 feet in elevation, which is 100 percent for Sneffels Creek. The Northwest Region considers drainage area, percent drainage above 7500 feet elevation, and mean annual precipitation. Lastly, the Mountain Region uses drainage area,

mean annual precipitation, and mean watershed slope. Peak flow estimates for the entire Sneffels Creek drainage basin and at the project site using StreamStats are summarized in Table 2 and Figure 2.

Table 1: Variables used in StreamStats regional regression equations.

Variable	Variable Definition
A	Drainage area, in square miles
A_{7500}	Percentage of A above 7500 feet in elevation
P	Mean annual precipitation, in inches
S	Mean watershed slope, in percent

Table 2: Summary of peak flow estimates (cfs) for the whole basin and at the project site of Sneffels Creek using three regional regression equations.

Recurrence Interval	Southwest Region		Northwest Region		Mountain Region	
	Whole Basin (cfs)	Project Site (cfs)	Whole Basin (cfs)	Project Site (cfs)	Whole Basin (cfs)	Project Site (cfs)
2-year	111	82	154	111	226	158
5-year	203	150	226	161	289	203
10-year	281	209	277	198	323	226
25-year	408	304	342	244	369	260
50-year	503	377	394	282	422	297
100-year	604	454	446	319	445	313
200-year	695	525	484	347	462	325
500-year	896	676	564	406	521	367

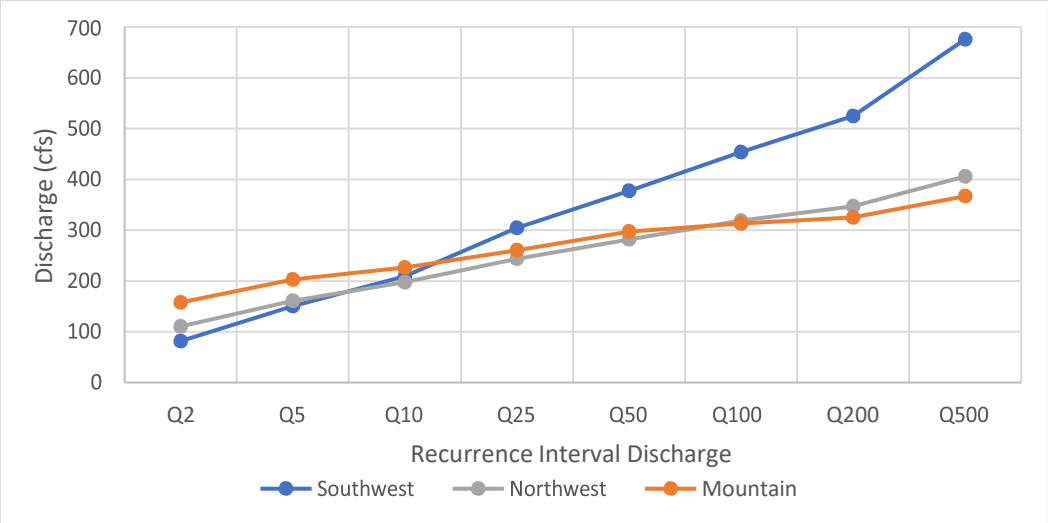

Figure 2: Summary of peak flow estimates (cfs) at the project site on Sneffels Creek using three regional regression equations.

The Northwest and Mountain regional regression equations estimate the smaller, more frequent peak flows (2- to 10-year) to be larger than the Southwest regional regression equation estimates. Conversely, the Northwest and Mountain regional regression equations estimate the higher, less frequent peak flows (25- to 500-year) to be smaller than the Southwest regional regression equation estimates.

Result comparisons suggest that there may be increasing uncertainty in the peak flow values with increasing recurrence interval discharge.

Other Available Hydrology Data

The EECA Atlas Mill Site report provided by Geosyntec documented discharge measurements taken at the project site from 2012 through 2017, with maximum recorded peak flow of 150 cfs. This value is near double the 2-year peak flow value estimated by StreamStats for the Southwest Region (82 cfs), but close to the estimated 2-year event using the Mountain Region (158cfs). More specific correlation of the project site measurements and application to help inform frequency-discharge relationships would require more information on the timing and number of measurements taken at the project site.

No other discharge data were found for Sneffels Creek.

Historical streamflow data were found in an adjacent drainage basin on Red Mountain Creek that is a tributary to the Uncompahgre River. In general, Red Mountain Creek has similar basin characteristics (Table 3), so the gage data can help inform the peak flow estimates by comparing the measured streamflow data with Streamstats outputs for Red Mountain Creek (Table 3). The historical streamflow data were available for the period from 1947 to 1955. Only monthly streamflow volume data in acre-feet were available. Peak flows using monthly values will likely underestimate the actual peak flows that occurred during the month because of the effect of averaging.

The volume data were converted to (cfs) and compared to estimated peak flow values calculated by StreamStats for the Red Mountain basin. The peak flows for the gage data available from 1947 to 1955 ranged from 107 to 177 cfs, which seem reasonable in comparison to the StreamStats estimated 2-year discharge of 188 cfs. The range of peak flows are slightly smaller than expected for a 5-year period but this may be because the monthly values don't capture the highest peaks or because 1947 to 1955 was a relative drought period.

Table 3: Comparison of watershed parameters for Sneffels Creek and Red Mountain Creek.

StreamStats Parameter Code	Parameter Description	Sneffels Creek	Red Mountain Creek	Units
DRNAREA	Area that drains to a point on a stream	4.89	18.1	square miles
EL7500	Percent of area above 7500 ft	100	100	percent
ELEV	Mean Basin Elevation	12241	11399	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	54.6	48.4	percent
ELEVMAX	Maximum basin elevation	14100	13500	feet
PRECIP	Mean Annual Precipitation	42.3	40.36	inches
MINBELEV	Minimum basin elevation	10700	9580	feet
LFPLENGTH	Length of longest flow path	3.7	7.92	miles
LC11BARE	Percentage of barren from NLCD 2011 class 31	49.6	19.5	percent

Current gage data on the Uncompahgre River near Ouray were also utilized to compare the StreamStats outputs with gage data. The Uncompahgre River is further downstream and much bigger than Sneffels Creek but has the only available current streamflow data for comparison. Peak flows for the Uncompahgre near Ouray for the same time period for which discharge measurements were taken at the project site (2012 through 2017) ranged from 451 to 1200 cfs, with an estimated 2-year of 475 cfs, 5-year of 829 cfs, and 10-year of 1120 cfs using StreamStats. These discharges seem reasonable, although consistently on the high end, ranging from a 2-year to 10-year flow over the six year period. More information about the field measurements of discharge taken in Sneffels Creek would be helpful to better understand if this comparison aligns with StreamStats outputs for Sneffels Creek.

Precipitation data were also not available in the Sneffels Creek Basin. However, there are three SNOTEL sites located to the South of the project site (Idarado elev. 9800ft, Red Mountain Pass elev. 11,200ft, and Mineral Creek elev. 10,040ft). Refer to Figure 3, and estimated precipitation contours from the Uncompahgre Watershed Plan from 2013 (Figure 4).

Average total precipitation values (1981 to 2010) varied among the three SNOTEL sites with Red Mountain Pass having the highest precipitation totals due to its higher elevation (Figures 5 a-c). The Sneffels Creek project site sits at ~10,700 feet and is closest to Red Mountain Pass SNOTEL site.

StreamsStats estimated the annual average precipitation at the project site to be 42.3” which seems reasonable in comparison to the 42.9” measured at Red Mountain Pass SNOTEL site. The precipitation estimate from the Uncompahgre Watershed Plan is approximately 38”, which is lower than the other estimates but is close considering the resolution of the contours (Figure 4).

The comparison of precipitation values show that the estimated value used in the StreamStats regression equations is reasonable but may need to be further refined for more complex hydrologic models and for use in analysis and design of potential tailings protection treatments.

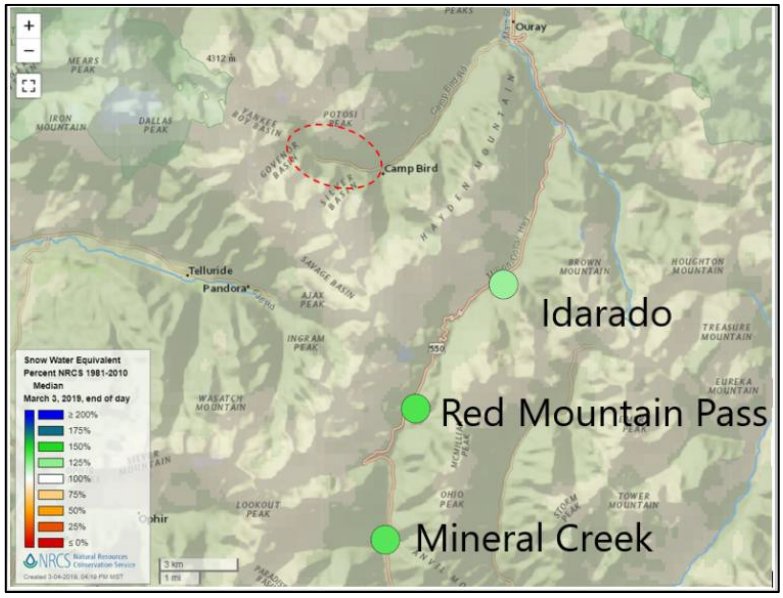

Figure 3: Three SNOTEL sites available near Sneffels Creek (circled with red dashed line).

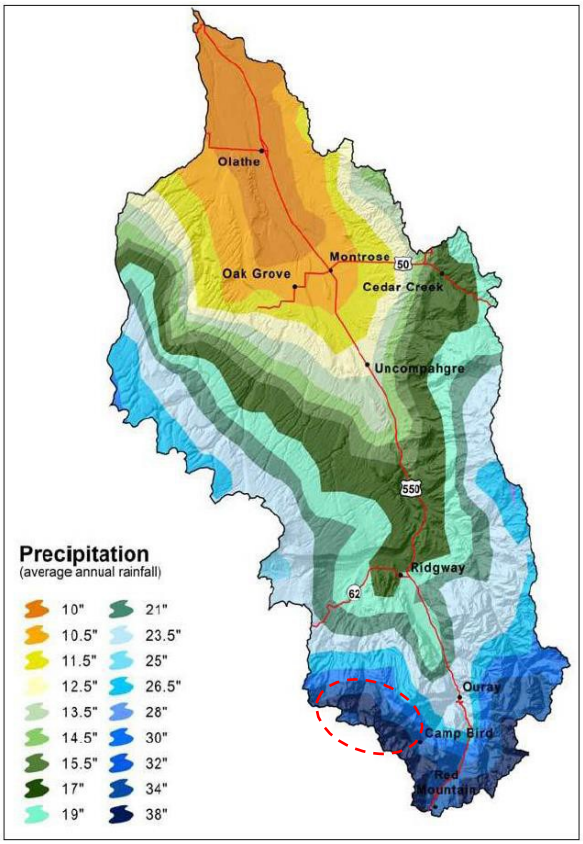

Figure 4: Average annual precipitation contours from Uncompahgre Watershed Plan with Sneffels Creek (circled with red dashed line).

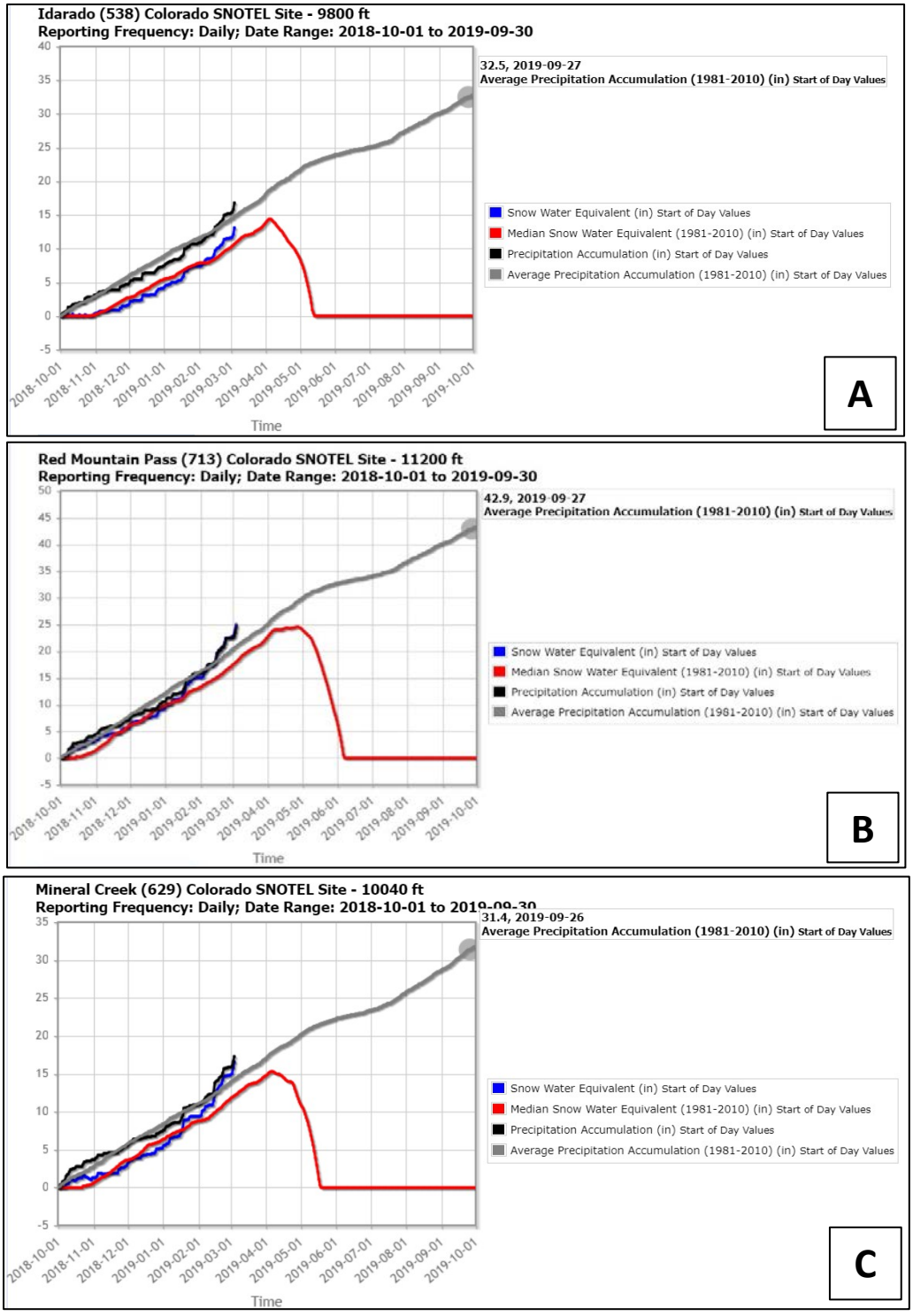

Figure 5: Outputs for three available SNOTEL sites near Sneffels Creek at A) Idarado, B) Red Mountian Pass, and C) Mineral Creek.

Conclusions/Recommendations

Peak flow estimates for Sneffels Creek are challenging because of the lack of available data for the watershed. StreamStats can be a useful tool to provide reasonable estimates with limited data, however StreamStats still has much uncertainty using very simplified regional regression equations. Data available from nearby basins provide multiple lines of evidence to support the estimates provided by StreamStats and can give indication to the uncertainty in the results.

Further information about the onsite field measurements of discharge taken from 2012 to 2017 would provide useful hints as to how the StreamStats outputs compare to actual values. Additionally, continuing to take field measurements of the discharge through time will be very helpful in understanding the streamflow trends for the basin.

The provided peak flow estimates from this analysis should be taken as a potential range of peak flows rather than absolute values.

Summary of the estimated range of peak flows is provided in Table 4.

Table 4: Summary of the estimated range of peak flows for Sneffels Creek at the Atlas Mill Site

Recurrence Interval	Project Site Peak Discharge (cfs)	Recurrence Interval	Project Site Peak Discharge (cfs)
2-year	82-158	**50-year**	282-377
5-year	150-203	**100-year**	313-454
10-year	198-226	**200-year**	325-525
25-year	244-304	**500-year**	367-676

A more detailed and refined analysis of the basin would help develop more sophisticated hydrologic model(s) to provide more supported estimates of peak flow discharges. The intended use of the peak flow approximations should guide decisions on how to best refine the estimates and which approaches are most suitable.

For example, using a conservatively high estimate for a selected design flow (e.g., 50-year) may suffice for simple rock sizing calculations to design a resistive bank treatment to locally protect tailings areas. More comprehensive analysis and design is required, however, to specify treatments that protect against a broader range of potential future conditions (to reduce surprises), like avulsion into a new flow path during flood event.

Understanding and working with natural fluvial processes (e.g., natural erosion and deposition) is required for the more holistic design, which requires consideration of the full range of flows, as well as sediment transport through the reach. This approach requires investment in detailed analysis to refine rapid approximations of peak discharge values, which may be warranted in higher risk areas where increased protection that is better suited to perform over the longer term is desired and/or when stream health and function are companion goals to prevention of flows from accessing tailings.